सत्यमेव जयते
DEPARTMENT OF
PERSONAL & TRAINING(DoPT)

Dr.Marri Channareddy
Human Resource Development
Institute of Telangana

TRIBAL WELFARE DEPARTMENT

GOVERNMENT OF INDIA, DEPARTMENT OF PERSONNEL & TRAINING SPONSORED TRAINING FOR ALL: INTENSIVE TRAINING PROGRAMME (ITP) TO THE FUNCTIONARIES OF TRIBAL WELFARE DEPARTMENT, GOVERNMENT OF TELANGANA

THREE DAYS TRAINING COURSE ON

TENDER PROCEDURES AND CONTRACT ADMINISTRATION,

INTRODUCTION TO GREEN BUILDING CONCEPTS IN ASHRAM SCHOOLS,

ALTERNATE CONSTRUCTION TECHNOLOGIES IN CONSTRUCTION OF SCHOOL BUILDINGS

AND

BEST CONSTRUCTION PRACTICES IN RURAL ROAD FORMATION IN TRIBAL AREAS

TO

TRIBAL WELFARE ENGINEERING STAFF

INTENSIVE TRAINING PROGRAM (ITP-TWD)

THREE DAYS TRAINING COURSE TO THE FIELD FUCNTIONARIES OF TW ENGINERING DEPARTMENT

Dr. Marri Chenna Reddy Human Resource Development Institute of Telangana

&

Tribal Welfare Department, Telangana State

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CHAPTER-1 MONITORING AND INFORMATION SYSTEM

1.1Introduction

The Tribal Welfare Department is providing infrastructure facilities towards enhancing literacy and health condition to Scheduled Tribes in the state of Telangana. The Engineering wing of the TW Dept is supervising the implementation of all infrastructure works related to Educational, Health and Rural Road connectivity in Tribal Areas of the state of Telangana.

The Department of Personnel and Training, Govt of India has proposed a policy decision of the Government that trainings to staff in all departments are to be provided to enhance quality in dischargement of their duties and ultimately to enhance the productivity of the departments concerned.

1.2: STRUCTURE AND FUNCTIONS OF THE DEPARTMENT

Formation of Engineering Wing in TW Dept:

Before April 1984, the Rural Infrastructure works in Scheduled areas were got to be executed through Panchayat Raj, R&B , I&CAD Depts,ExclusiveEngg Wing in TW Dept is formed through G.O Ms No 78 Dated 24th April 1984. Exclusive Service Rules came into force through G.O Ms No 67 Dated 12th April 1994

Intended to serve in ITDA areas

1) Original areas - 8 Numbers – (Seethampeta, Parvathipuram, Paderu, Rampachodavaram, K.R.Puram,Bhadrachalam, Eturunagaramand Utnoor)
2) Extended to another -3Numbers (Nellore, Srisailam and Plain Areas (Hyderabad))

After bifurcation of the combined state, in Telangana State, now functioning in all 31 districts of 5 ITDAs viz

1. Utnoor (Adilabad, Asifabad, Mancheriyal, Nirmal)
2. Eturunagaram (Warangal (U) & (R), Bhoopalapally, Mahabubabad,Jangaon)
3. Bhadrachalam (Bhadradri, Khammam)
4. Mannanur (Mahabubnagar, Gadwal, Wanaparthi, Nagarkurnool)
5. Plain Areas (Other Plain area districts)

Major Areas of Infrastructure in which TW Engineering Department is involvedInfrastructure for all Tribal Welfare Department owned Institutions such as Educational Institutions ,Ashram Schools and Hostels, Post Matric Hostels,Residential Schools and Colleges,Model ITIs/Poly Technics etc.

Health Institutions such as Primary Health Centers, Sub Centers, Anganwadi Centers ,Office Buildings like ITDA offices, Staff Quarters, HNTCs, Vocational Training Centers, Gram Panchayat Buildings, Working Women Hostels, Youth Training Centers etc Rural Road Infrastructure in ITDA area districts

Major Work Programs under taken after bifurcation

S.no	Institutions	Total
1	Residential School Complexes	51
2	Post Matric Hostels	52
3	Youth Training Centers	04
4	Working Womens Hostels	10
5	Girijan Bhavan	30
	Total	147

ResidentialSchool Complexes - 51 Nos – Each Rs 4.20 Crores

Main Components in 1st Phase
Dormitory Block
Principal and Staff Rooms
Dining & Kitchen
8 Class Rooms
16 Dormitory Rooms
OHSR – 40/60KL
Compound Wall for Girls Institution

Residential School Complex

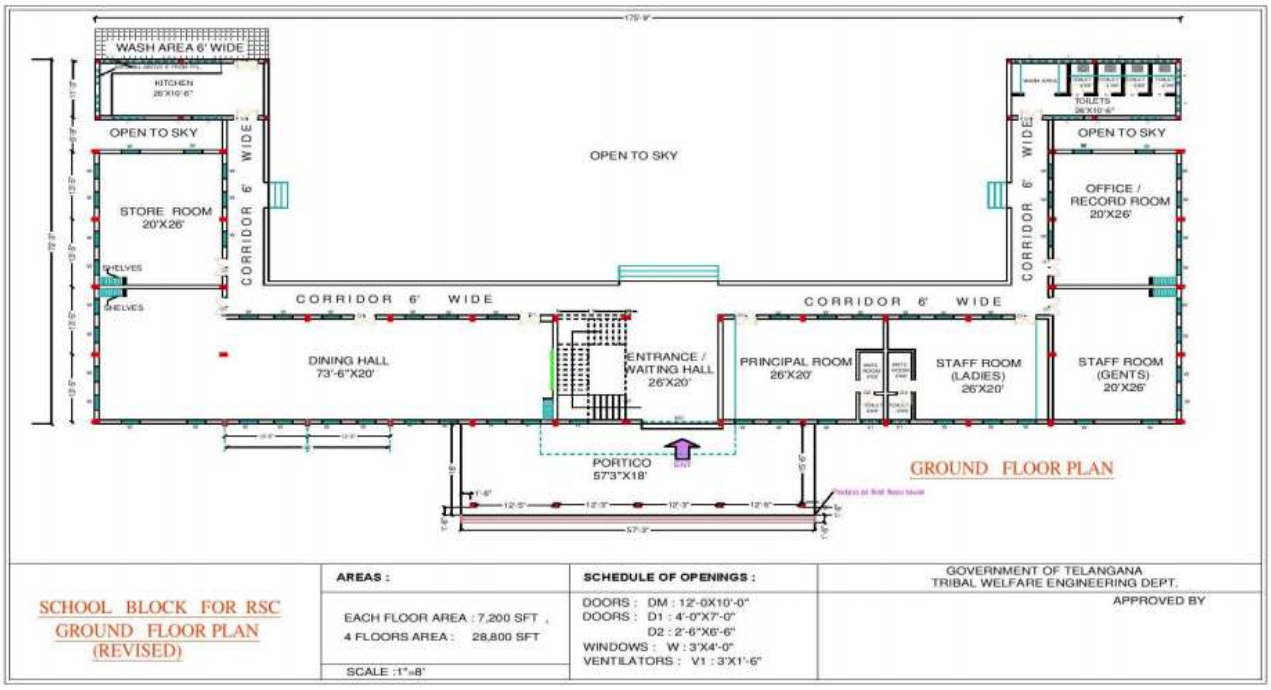
Residential Schools are taken up to upgrade the educational system in tribal areas for which, (51)No.of Residential Schools are taken up with an outlay of Rs.214.20 Crs.

(Rupees in lakhs)

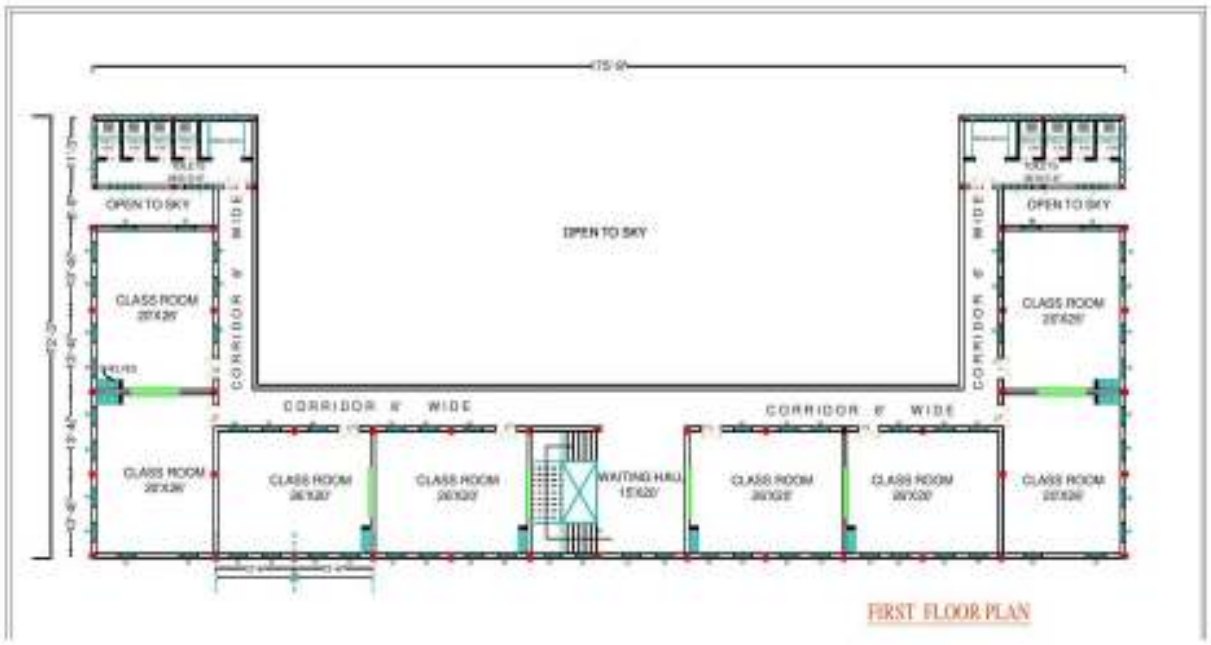
S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Bhadrachalam	6	2520.00	1451.45	5	1	0
2	Eturunagaram	7	2940.00	1809.25	5	2	0
3	Utnoor	6	2520.00	415.86	1	5	0
4	Hyderabad	32	13440.00	2507.09	5	16	11
	Total	51	21420.00	6183.67	16	24	11

Major Work Programs under taken after bifurcation

Residential school complex Ground floor plan

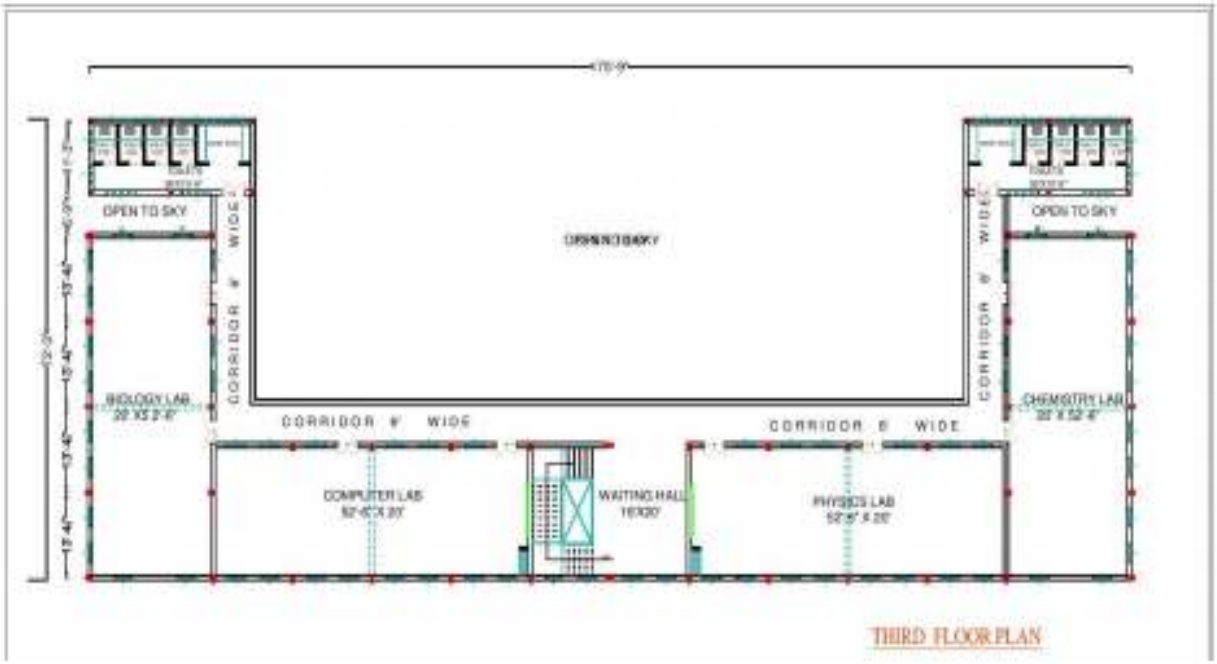


Residential school complex First floor plan



Residential school complex Second floor plan

Residential school complex Third floor plan



Major Work Programs under taken after bifurcation

Post Matric Hostels

Post Matric Hostels for Boys/Girls –
52 Nos – Each Rs 1.70 Crores/ Rs 2.15 Crores
Main Components
Dormitory Block
G+ 2 Floors
Each Floor having 4 Rooms to accmodate
16 Borders with dual cot facilities
Attached with Toilet Block in each floor
Dining Cum Kitchen for 200 pax
Compound Wall for Girls Institution

Post Matric Hostel

To encourage residential education among STs and to reduce literacy rate in tribals. (52) No.of Post Matric College Hostels are taken up with an out lay of Rs.92.95 Crs

Rs.in lakhs

S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Bhadrachalam	13	2300.00	1206.15	11	2	0
2	Eturunagaram	8	1410.00	880.59	5	2	1
3	Utnoor	4	680.00	383.44	4	0	0
4	Hyderabad	27	4905.00	760.20	7	7	13
	Total	**52**	**9295.00**	**3230.38**	**27**	**11**	**14**

Major Work Programs under taken after bifurcation

Working Women Hostels

Working Women Hostels – 10 Nos – Each Rs 2.75 Crores
Main Components
Dormitory Block
G+ 2 Floors
Dining cum Kitchen Room
Matron Room
Dormitory for 128 in 2 Floors
Attached Toilet Block in each floor
Compound Wall

Working Womens Hostels are taken up to provide the safe and secured accommodation to rural ST Working Womens. For which (10) no.of Working Womens Hostel in were taken up with an outlay of Rs.27.50 Crs.

Rs.in lakhs

S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Bhadrachalam	1	275.00	31.14	1	0	0
2	Eturunagaram	1	275.00	25.42	0	1	0
3	Utnoor	1	275.00	250.71	1	0	0
4	Hyderabad	7	1925.00	372.12	2	2	3
	Total	**10**	**2750.00**	**679.39**	**4**	**3**	**3**

Major Work Programs under taken after bifurcation

Youth Training Centre

Youth Training Centres – 4 Nos – Each Rs 4.60 Crores
Used as Skill Development centers
Main Components
G+ 2 Floors
Front Block
Academic Purpose
Side Blocks
Dormitory Purpose to accommodate 200 borders (10
Rear Block
Dining Cum Kitchn
Encased Compound Wall

Youth Training Centre Ground floor plan

Youth Training Centers are taken up to provide skill development up-gradation and training programme in various trades for educated un-employed youth. For which (04) No.of Youth Training Centers were taken up with an out lay of Rs.18.60 Crs

Rs.in lakhs

S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Bhadrachalam	1	465.00	281.75	1	0	0
2	Hyderabad	3	1395.00	637.47	1	2	0
	Total	4	1860.00	919.22	2	2	0

Major Work Programs under taken after bifurcation

Ekalavya Model Residential Schools-4 Numbers – Each Rs 12.00 Crores

Main Components
School Block G+ 2 Floors
Dormitory Block G+ 2 Floors
Dining Cum Kitchen Block
Principal Quarters
OHSR
Compound Wall
Internal Access Road
Play field

Ekalavya Model Residential School

Centrally Sponsored Scheme:

Article 275(I) Grant (GoI) :

(5) Ekalavya Model Residential Schools were sanctioned, out of which (1) work is sanctioned at Seerole (V) Warangal District, during the year 2014-15 with an estimated cost of Rs.12.50 Crs and the same is completed. During the year 2017-18 (4) EMRS were sanctioned at (1) Kalwakurthy, (2) Indalwai, (3) Palwancha and (4) Gandugulapally with an estimated cost of Rs.12.00 Crs per each.

Rs.in lakhs

S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Bhadrachalam	2	2400.00	1521.04	0	2	0
2	Eturunagaram	1	1250.00	1148.68	1	0	0
3	Hyderabad	2	2400.00	409.74	0	2	0
	Total	**5**	**6050.00**	**3079.46**	**1**	**4**	**0**

Girijan Bhavans Banjara Bhavan and Komarambheem Bhavans

Girijan Bhavans

Adivasi KomaramBheem Bhavan and Banjara Bhavan in Hyderabad were sanctioned with an estimated cost of Rs.20.00 Crs per each during the year 2016-17 and the work is under progress. These are provided for better facilities to conduct cultural activities like, meetings, marriage functions and exhibitions conventions etc.,.

(28) No.ofGirijan Bhavans and Darbar halls were sanctioned in erstwhile (9) District Head Quarters, (12) ST Assembly Constituency Head Quarters and (3) ITDA Headquarters with total outlay of Rs.29.95 Crs. These are provided at constituency level for meetings and functions of tribal's in these areas.

Rs.in lakhs

S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Bhadrachalam	6	660.00	172.97	2	3	1
2	Eturunagaram	5	550.00	219.43	3	2	0
3	Utnoor	7	705.00	374.37	5	2	0
4	Hyderabad	12	5080.00	1557.52	1	3	8
	Total	**30**	**6995.00**	**2324.29**	**11**	**10**	**9**

Major Work Programs under taken after bifurcation

Habitations having above 250 ST population

Total Habitations .. 3405
(3) ITDA Areas .. 2078
Plain ITDA Areas .. 1327
Already connected habitations .. 2897
(3) ITDA Areas .. 1846
Plain ITDA Areas .. 1051
Balance habitations to be connected .. 508 with length of 1075.36 KMsfor an amount of Rs.721.74Crs
(3) ITDA Areas .. 232
Plain ITDA Areas .. 276

Habitations having below 250 ST population

Total Habitations .. 9071
(3) ITDA Areas .. 6485
Plain ITDA Areas .. 2586
Already connected habitations .. 6543
(3) ITDA Areas .. 5406
Plain ITDA Areas .. 1137
Balance habitations to be connected .. 2528 with length of 4291.37 KMs for an amount of Rs.2953.91 Crs
(3) ITDA Areas .. 1079
Plain ITDA Areas .. 1449

Infrastructure in (3) ITDA Districts :

BT Roads are provided to connect the tribal habitations to the main stream of the Mandal/district headquarters, to improve the connectivity in (3) ITDA Tribal Areas, (614) BT Road works were taken up with an estimate cost of Rs.648.74 Crs during the financial years 2016-17, 2017-18 and 2018-19.

Rs.in lakhs

S. No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
	2016-17 & 2017-18						
1	Bhadrachalam	119	9825.70	4709.34	105	10	4
2	Eturunagaram	156	9729.00	6654.66	131	20	5
3	Utnoor	98	8451.65	5142.31	87	6	5
	Sub Total	373	28006.35	16506.31	323	36	14
	2018-19						
1	Bhadrachalam	64	11167.00	4430.80	26	38	0
2	Eturunagaram	117	15361.20	5028.15	54	61	2
3	Utnoor	60	10340.32	2196.65	31	20	9
	Sub Total	241	36868.52	11655.60	111	119	11
	Total	614	64874.87	28161.91	434	155	25

BT ROADS IN ST HABITATIONS :: To improve the connectivity in Plain ITDA Areas,

Rs.in lakhs

S. No.	Executed by	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	Tribal Welfare Engineering Department	73	10602.20	3973.81	29	27	17
2	Panchayat Raj Engineering Department	474	51560.08	12384.67	193	220	61
	TOTAL	547	62162.28	16358.48	222	247	78

(a)-(73) BT Road works were taken up with an outlay of Rs.106.02 Crs during the financial year 2017-18 and 2018-19 and were executed by Tribal Welfare Engineering Department.

Rs.in lakhs

S.No.	Name of the Division	Works Sanctioned		Expenditure incurred so far	Physical stage		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
	2017-18						
1	Hyderabad	25	4671.00	846.93	5	15	5
	Sub Total	25	4671.00	846.93	5	15	5
	2018-19						
1	Hyderabad	48	5931.20	3126.88	24	12	12
	Sub Total	48	5931.20	3126.88	24	12	12
	Total	73	10602.20	3973.81	29	27	17

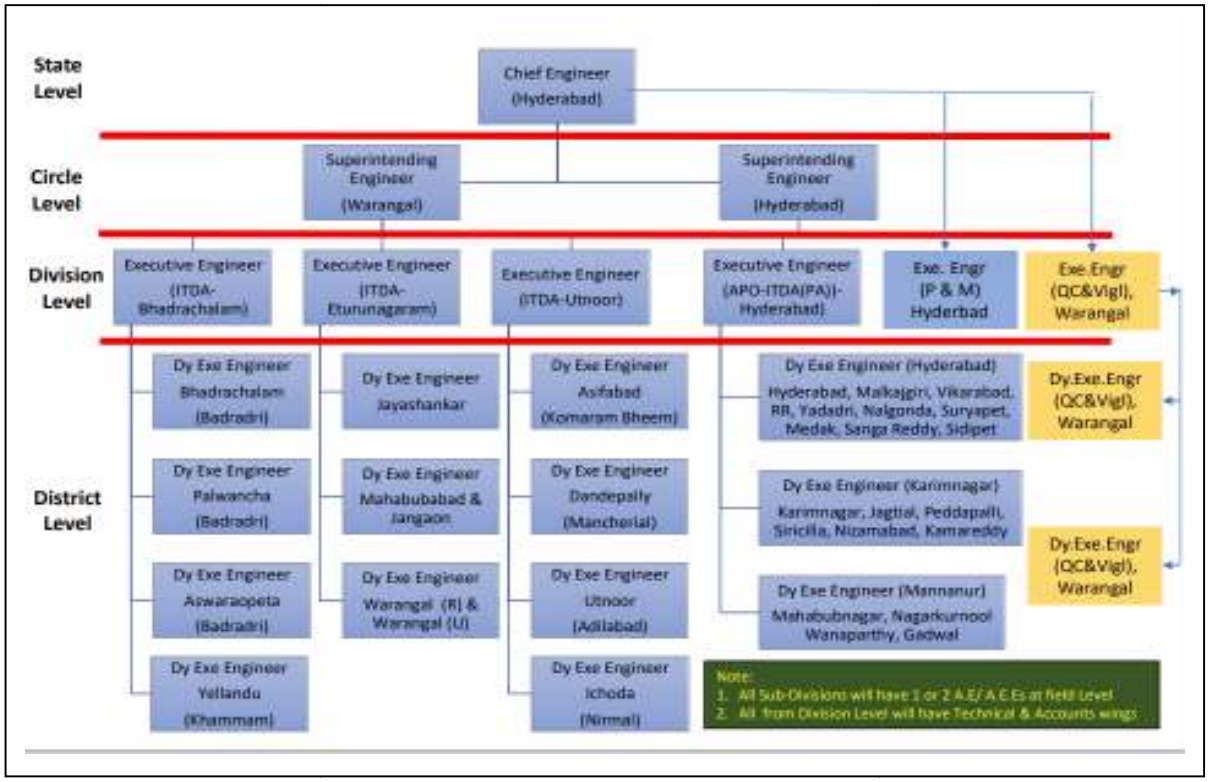
(b)-(474) BT Road works were taken up with an outlay of Rs.515.60 Crs during the financial year 2017-18 and 2018-19 and executed by Panchayat Raj Engineering Department.

Rs.in lakhs

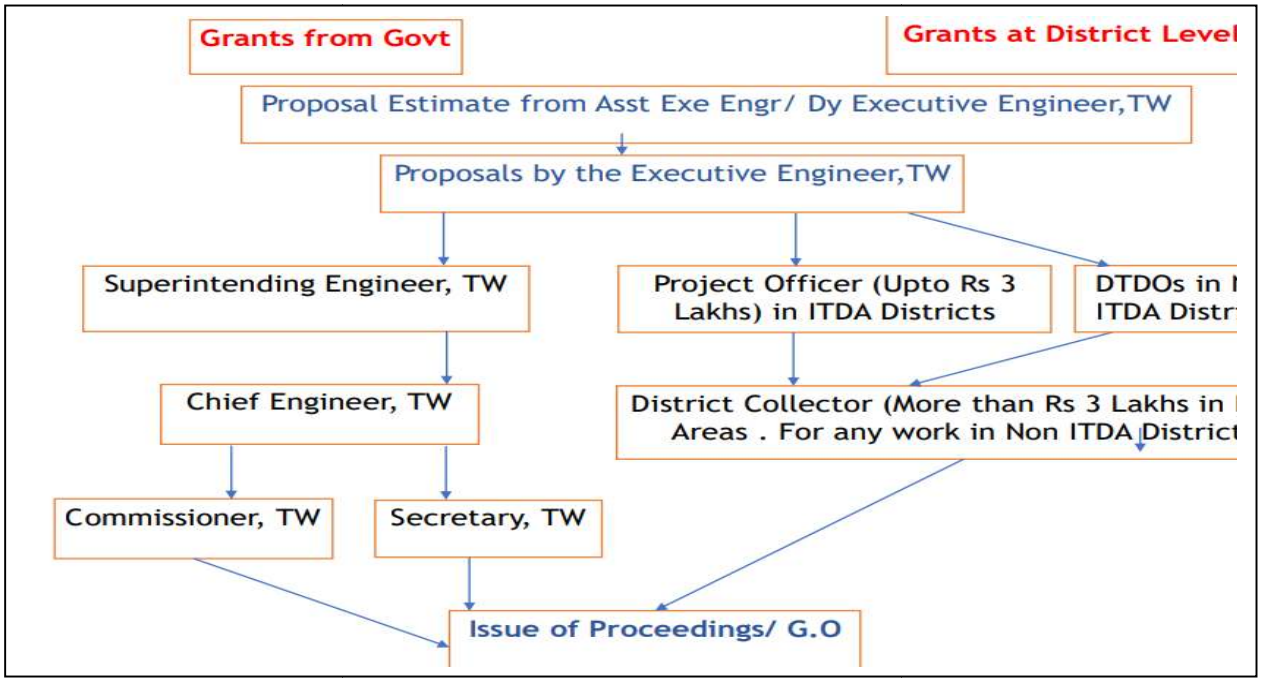
S. No.	Year of sanction	Works Sanctioned		Expenditure incurred so far	Present Status		
		Nos.	Amount		Completed works	Progress	To be started
1	2	3	4	5	6	7	8
1	2017-18	212	20312.2	9759.02	148	62	2
2	2018-19	262	31247.9	2625.65	45	158	59
	Total	474	51560.1	12384.67	193	220	61

Tribal Welfare Engineering Department Hierarchy

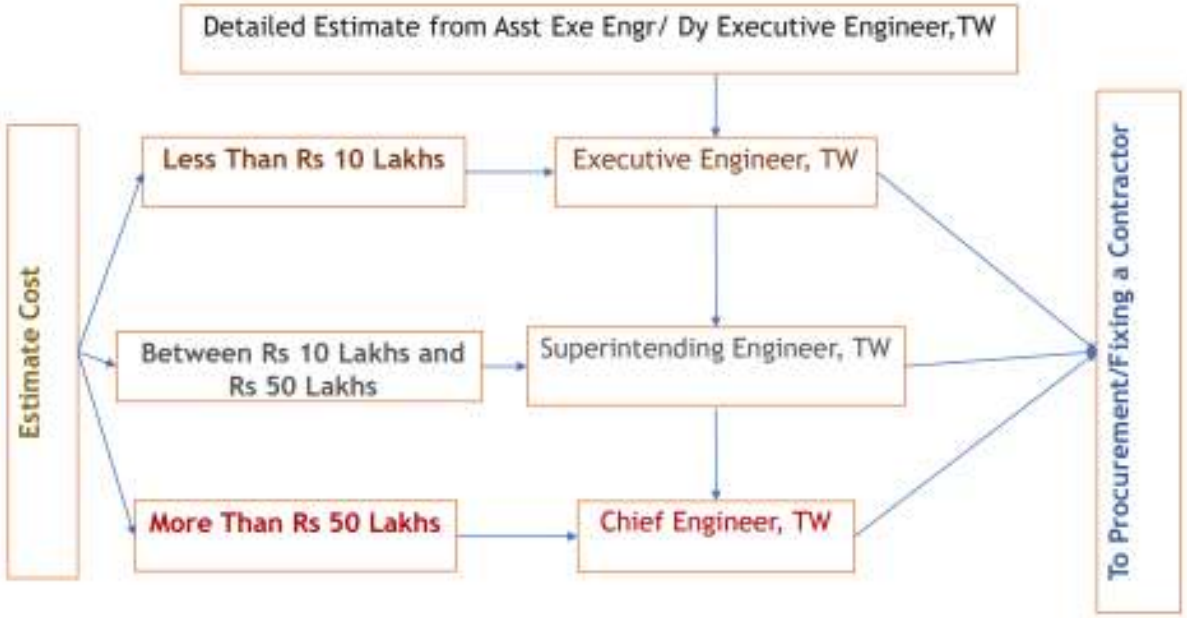
Organogram of Tribal Welfare Engineering Department



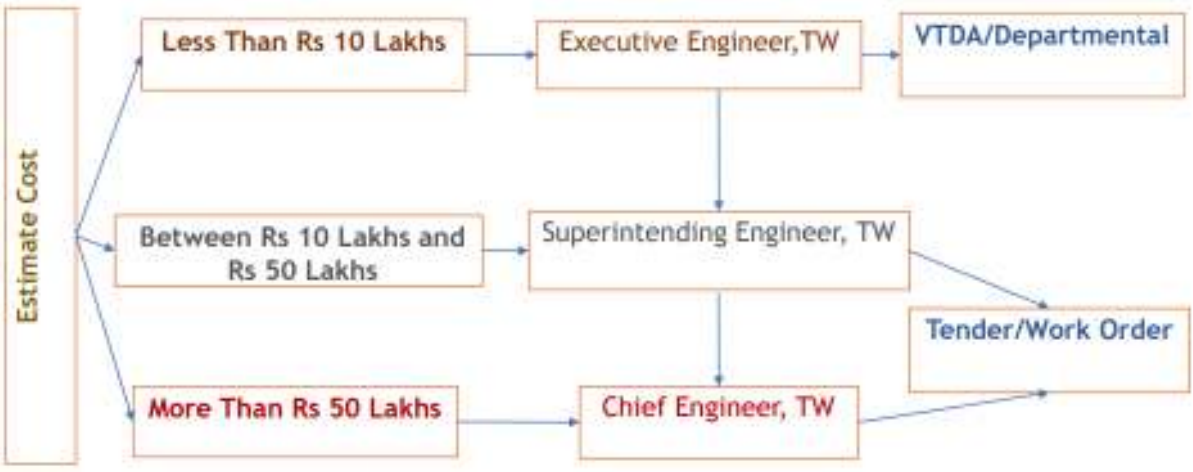
Procedure / Powers of Administrative Sanction of works



Procedure / Powers of Technical Sanction of works



Procedure / Powers of Procurement/Entrustment/Tenders of works



1.3 :Roles , Responsibilities of Technical Staff

Reasons for Creation of these Field Functionaries

Chief Engineer, TW

He/She is the Executive Head of TW Engg Dept. He/she is the advisor to the Government on all matters relating to the department. He/She is responsible for execution of schemes and administrative control over the entire Tribal Welfare Engineering Department.

Superintending Engineer,TW

He/She is in-charge of the administrative circles in the TWTribal Welfare Engg Dept. He/She is answerable to the Chief Engineer in all administrative & technical matters and execution of works in the circle.

Executive Engineer,TW

He/She is in-charge of the Executive unit of the department i.e., Engineering Division. He/She is answerable to Superintending Engineer for execution and management of works and administration in the division.

Executive Engineer, (Projects &Monitoring) ,TW

He/She is to assist the Chief Engineer in discharging (Projects & Monitoring) the later's duties as prescribed above. He will be Drawing and Disbursement Officer in the office of the Chief Engineer. Coordinates with all Circle/Division offices in Communication and Monitoring of Progress.

Executive Engineer,Quality Control &Vigilance,TW

He/She is in-charge of the Quality Control and Vigilance activities in the state. Works under direct control and reports to the Chief Engineer.

Divisional Accounts Officer

He/She is responsible for pre-audit of payments made at Division. He/She is to assist the Executive Engineer in all accounts related functions.

Deputy Executive Engineer

He/She is in-charge of Engineering Sub Division and is answerable to the Executive Engineer for management and execution of works within the sub division.

Assistant Executive Engineer/ Assistant Engineer

He/She is in-charge of the works in his/her Engineering Section. He/She is responsible for investigation, preparation of estimates, execution, co-management and recording measurements, preparation of bills etc. He/Sheworks under the control of the Dy. Executive Engineer. He/She exercises control over the Work Inspectors and is primarily responsible for maintaining quality of works, their timely execution and maintenance of all basic records pertaining to this/her section.

Functions to be discharged - Classification

Field functions

Desk functions

Statutory functions

Functions to be discharged by Chief Engineer

Field Functions

1. Field Inspection of works to bring out the lapses or irregularities in execution
2. Issues a brief note/inspection report to be communicated to the concerned for rectification/rejection.
3. Maintain Quality and for streamlining the procedures for better execution of works

Desk Functions

1. Administrative control of the Department
2. Technical control of the Department
3. Advises the Government of Telangana on all matters pertaining to TWED
4. Initiates disciplinary action on the erring officials as per CCA rules
5. Appoints AEE/Aes& DM Gr-I depending upon the requirement and sanctioned posts in the Dept.
6. Initiates proposals for additional staff whenever required
7. Preparing panels for all categories of posts in his office and functionaries and to accord promotions to the extent empowered and send to Government to effect promotions to all posts from level of Dy.Exe.Engineers onwards with his recommendations.
8. Sanctions Earned Leave to Executive Engineers on the recommendations of the PO, ITDA and sub-ordinate staff coming under CE's purview
9. Obtains and maintains confidential reports for all executive staff in TWED and communicates adverse remarks if any to the persons concerned.Desk Functions Functions to be discharged by Chief Engineer
10. Prepares annual budget for regular establishment of the Tribal Welfare Engineering Department.
11. Prepares annually, the portion of the budget estimates relating to the works under his control.
12. Prepares plan of action in respect of all the schemes/programmes to be executed by TWED and monitors progress of execution of works and sending periodical reports.
13. Submit proposals to the Government in respect of transfers and postings of Superintending Engineers and Executive Engineers in TWED (Para No.7, of A.P.P.W.D Code)
14. Conducts monthly review on progress of works, controls Materials at site accounts (MAS, 7F accounts) conducts periodical meetings with Superintending Engineering and Executive Engineers and initiates suitable measures to ensure speedy execution of works.
15. Review super check measurements/check measurements done by Executive Engineers.
16. Sends progress reports to Government of Telangana
17. Sends reports on LAQ's/RSQs and Assurances on the floor of the Assembly. Desk Functions Functions to be discharged by Chief Engineer
18. Maintains incumbency Register for all categories of functionaries.
19. Develops the human resources in the department by imparting trainings.
20. Sends replies to audit paras raised by A.G on the matters of Chief Engineer's office.

21. Sends replies to PAC paras and to attend PAC meetings.
22. Obtaining and Submission of Utilization Certificates for the grants released under Grantin-Aid.
23. To get the figures of department reconciled with those of A.G furnish monthly certificate to A.G
24. Transfers & Postings of Dy.Executive Engineers & Assistant Executive Engineers & Assistant Engineers (G.O.Ms.No.38, 14.03.85 of SW (V) Dept., & para 7 of A.P PWD Code).
25. Issue of increment certificate to Superintending Engineers.
26. Sanction of pension to all Non-Gazetted officers including class IV employees of his office and Gazetted officers in the Department (G.O.Ms.No:262, dt:23-11-98 of Finance & Planning (FW.PSC) Department).
27. Guide the sub-ordinate staff in discharging their functions.
28. Monitoring materials management by sub-ordinate offices.
29. Monitoring utilization of departmental machinery.
30. Drawing and distributing the salaries and allowances of the staff of O/o Chief Engineer, through P.A by nominating him as drawing and distributing officer (Sub Rule 2 (h) of Treasury Rule 16 A.P Treasury code Volumne-1).(Now EE,P&M is DDO)
31. Unit officer for ministerial staff of O/o Chief Engineer, Tribal Welfare, Hyderabad and O/o E.E QC & Vigilance, Tribal Welfare Hyderabad (G.O.Ms.No.114, dt:3-12-99 of Social Welfare (TW.Ser-II) Dept.,

Statutory Functions

1. Registration of class – 1 contractors (G.O.Ms.No.65, dt:3.7.99 of Social Welfare (TW.Ser.II1) Dept.,).
2. Accords Technical Sanction to estimates costing more than Rs.50.00 Lakhs and upto the value of the Administration approval (G.O.Ms.No.65, dt:3-7-99 of Social Welfare (TW.(Ser.II.1) Dept.,).
3. Calling and acceptance of tenders and entrustment on tender basis for the works costing more than Rs.50.00 lakhs and upto Rs 1 Crores (G.O.Ms.No.65, dt:3-7-99 of Social Welfare (TW.Ser.II-1) Dept.,(Now enhanced to Rs 10 Cr)
4. Recommending tenders for works costing above Rs.100.00 lakhs to the Commissioner of tenders, (G.O.Ms.No.65, dt:3-7-99 of Social Welfare (TW.Ser. (II-1) Dept.,(Now from Rs 10 Cr on wards)
5. Passing excess expenditure upto 15% over and above the technical sanction amount of the work (G.O.Ms.No.83, dt:17-4-85 of Social Welfare (V) Dept.,)
6. Passing excess expenditure on all works irrespective of total sanctioned estimate, without percentage limit upto Rs.10,000/- (G.O.Ms.No.83, dt:17.4.85 of Social Welfare (V) Dept.,).
7. Full powers for according technical sanction to detailed estimates of works upto amount administratively approved plus excess indicated below.

8. To accord technical sanction to detailed estimates upto 10% excess over administrative approval for works costing upto Rs.200.00 Lakhs subject to a limit of Rs.10.00 lakhs (G.O.Ms.No.83, dt:17.4.85 of Social Welfare Dept.,).
9. To accord technical sanction to detailed estimates upto 5% excess over administrative approval for woks costing above Rs.200.00 lakhs, subject to a limit of Rs.20.00 Lakhs (G.O.Ms.No.83, dt:17.4.85 of Social Welfare Dept.,).
10. Grant of Extension of agreement period for the tenders accepted by Superintending Engineer. Grants Extension of time upto six (6) months for the tenders accepted by Chief Engineer and Government and forwarding to the Government for the periods beyond 6 months. (G.O.Ms.No.83, dt:17.4.85 of Social Welfare Dept.,).
11. Technical sanction of Electrical Estimates for buildings where the electrical estimate exceeds more than Rs.1.00 Lakhs. Can dispense with tenders (power of nomination) upto Rs.50000/- for electrical estimates. Can accept tenders of electrical estimates upto technical sanction plus such percentage as Chief Engineer is competent to sanction under excess over estimates (Annexure-III, Sl.No.9 & 10 of Section No-11 of Executive Inspections of A.P PWD Code & G.O.Ms.No.1007, dt:5.11.1976 of TR & B Dept.,).
12. Exercising the Financial Powers delegated by Gov., in G.O.Ms.No.148, Dt:21.10.2000 of Fin & Planning (FW ADMN.1 TFR) Dept., and subsequent amendments/enhancements if any in respect of certain common items like stationery, furniture, Computer stationery and repairs to vehicles etc.,
13. Annual Inspection of circle office to bring out the lapses or irregularities if any in functioning of office through a detailed note to be communicated to the concerned for rectification in order to stream line the functioning of office.
14. The Chief Engineer has powers to sanction the dismantlement of State Government buildings when the book value of the building does not exceed Rs.10,000/-. Also the Chief Engineer has powers to make a sale of dismantled materials the book value of which does not exceed Rs.10,000/- (Para 235 of A.P PWD Code).

Functions to be discharged by Superintending Engineer

Field Functions

1. It is the duty of the Superintending Engineer to inspect important works in his circle, to satisfy himself that the system of management is efficient and economical, that regulations works, stock and accounts are strictly observed, and that the executive and administrative work of the circle is satisfactorily performed (Para – 14 of A.P PWD Code).
2. Field visits for monitoring the satisfactory execution of works and to review with Executive Engineers, Dy.Executive Engineers and Assistant Executive Engineers/Assistant Engineers and settlement of field problems, if any and ensuring quality in execution. He should submit his inspection reports to Chief Engineer.
3. Field visits in connection with enquiries.
4. Site Inspection of works before according technical sanction.

Desk Functions

1. Answerable to the Chief Engineer for the administration and execution of works in charge of officers of the department within his circle (Para-13 of AP PWD Code)
2. To post and transfer DEEs & AEEs/AEs within the respective zones in his circle. (Para – 18 of AP PWD Code & G.O.Ms.No.38, dt:14-3-1985 of Social Welfare (V) Dept., a) To appoint Draughtsman Gr.-II & III, Tracers and BPOs within his circle (G.O.Ms.No.143, dt:12.12.96 of SW (V) Dept.,) b) b) Unit officer for Ministerial staff of circle office and for Sr.Assistants and above in sub-Ordinate offices. (G.O.Ms.No.114, dt:3-12-99 of Social Welfare (TW.Ser-II) Dept.,)
3. To sanction EL to DEEs upto 3 months and AEEs/AEs upto 6 months (G.O.Ms.No.38, dt:14.3.85 of SW (V) Dept.,)
4. He should maintain a record of performance of contractors registered in his circle (as per G.O.Ms.No.65, dt:3.7.99 of Social Welfare Department).
5. Initiate disciplinary action on the erring officials as per A.P Civil Services (CCA) rules.
6. Maintain the relevant records and registers in circle office.
7. Initiate proposals for additional staff whenever required.
8. Watch the monthly and annual returns on the departmental Tools & Plants and take suitable measures to see that they do not run into loss.
9. Prepare budget for regular establishment and works programme of the circle.
10. Prepare plan of action in respect of all the schemes/programmes to be executed by TWED under his purview.
11. Watch the annual verification of stores by Executive Engineer and Bi-Annual verification of stores by Dy.Executive Engineer concerned, Material at site accounts and 7F accounts (Para 325 and 326 of 'D' Code) & (Article 139 & 143 of A.P Financial Code Volume-1).
12. Conducting monthly reviews on progress of works with Executive Engineers and Dy.Executive Engineers and take suitable measures to ensure that the system of execution of works programme is as per schedule.
13. Review super check measurements/check measurements done by Executive Engineers and Dy.Executive Engineers during the inspections of division offices (Para 296 of 'D' Code)
14. Sending progress reports to Chief Engineer on works programme.
15. Sending reports on LAQ's, LSQs/ RSQs and Assurances on the floor of the Assembly.
16. Maintain Incumbency Register for all categories of functionaries.
17. To develop human resources in the circle by imparting training etc.,
18. Prepare and send replies to audit paras raised by A.G on the functioning of his office.
19. Prepare and send replies to PAC paras
20. To ensure submission of Utilisation certificates for the grants released.
21. To get the figures of circle office reconciled with those of Treasury and obtain certificate from the Treasury and to send the certified figures to Chief Engineer every month.

22. Drawing & disbursing of salaries and allowances of staff of office of the Superintending Engineer, through PA by nominating him as drawing and disbursing officer. (Sub Rule 2 (h) of Treasury Rule-16 in A.P Treasury Code volume-1).
23. Watch and control the rates paid for work and he may require an Executive Engineer to report to him such details of expenditure as he may desire.
24. Sanction annual increments to staff of his office and Executive Engineers.
25. Responsible for ensuring quality in works programme.
26. He is the authority to accord permission for engagement of private road rollers (Cir No. T&P (2)/TA3/110793/75-1, dt:20.12.1975 of CE (R&B) AP Hyderabad-4 shown in section XVI, for rules and notification etc., of AP PWD Code 2 nd revised Edition-1977).
27. Guide the sub-ordinate staff in discharging their functions.
28. To attend review meetings convened by Chief Engineer and District Collectors.
29. Approval of quarry charts and Road Metal Rate Books.
30. (As per instructions issued in Govt. Memo.No.1611-Y/67-19, Dt:18.03.69 under sub-heading change in Quarries and leads of materials in Para 154 of AP PWD Code).
31. To maintain the seniority list of Work Charged establishment, Tracers, BPO's &Draughtsmen of circle.
32. Pension
    a) Sanction of pensions of all Non-Gazetted Officers including class-IV employees of his office.
    b) Forwarding the pension papers of all Gazetted Officers under his jurisdiction to the Chief Engineer (TW) (G.O.Ms.No.262, dt:23.11.98 of Finance & Planning (FW.PSC) Department)
33. Appellate authority for the Penalties and Punishments imposed by the Executive Engineer on contractors (PS 60 of A.P "Detailed standard specifications and General principles of Engineering). Submission of all information required by Government and Chief Engineer from time to time.
34. Check measure and super check the works at random and also as directed by Chief Engineer from time to time.
35. The Superintending Engineers are empowered to issue condemnation certificates in respect of vehicles in the Department (G.O.Ms.No.83, dt:17.4.85 of Social Welfare (V) Dept.,). He should ensure that all contractor's notices are replied to within 10 days.

Statutory Functions

1. Registration of class-II contractors (G.O.Ms.No.65, dt:3.7.99 of SW (TW Ser.II-1) Dept.,
2. According Technical sanction to works estimates costing more than Rs.10.00 Lakhs and upto Rs.50.00 Lakhs including approval of designs (G.O.Ms.No.65, dt:3.7.99 of SW Ser.II-1) Dept.,)
3. Calling and acceptance of tenders and entrustment of tender basis for works costing more than Rs.10.00 Lakhs and upto Rs.50.00 Laksh (G.O.Ms.No.65, dt:3.7.99 of SW (TW.Ser.II-1) Dept.,)

4. Accepting tenders upto 15% excess over estimate rates (G.O.Ms.No.65, dt:3.7.99 of SW (TW.Ser.II-1) Dept.,)
5. Passing excess expenditure upto 10% over and above the technical sanction amount of the work subject to the limit of technical sanction powers.
6. Accord Technical sanction to detailed estimates upto 10% excess over administrative sanction subject to limit of technical sanction powers (G.O.Ms.No.83, dt:17.4.85 of SW (V) Dept.,)
7. Passing excess expenditure on all works irrespective of total sanctioned estimate without percentage limit up to Rs. 6,000/-. (G.O.Ms.No.83, dt.17.4.85 of S.W (V) Dept.)
8. The Superintending Engineer has no powers to sanction excess over estimates sanctioned by the Chief Engineer. (G.O.Ms No.83, dt.17.4.85 of S.W. (V) Dept.)
9. Grant of Extension of time for the tenders accepted by Executive Engineer. (G.0.Ms.No.83, dt.17.4.85 of S.W (V) (TW.Ser.11-1) Dept.)
10. Technical sanction of Electrical Estimates to buildings up to Rs.1.00 lakh. Can dispense with tenders (power of nomination) up to Rs.2,500/- for electrical estimates. Can accept tenders of electrical estimates up to Rs.1,00,000/-. (Annexure III of Section No.11 of Executive Instructions of A.P. PWD Code & G.O.Ms.No.1007, dt.5.11.1976 of TR & B Dept.)
11. Exercising the Financial Powers delegated by Govt., in G.O.Ms.No.148 Dt.21.10.2000 of Fin. & Planning (FW ADMN 1 TFR) Dept. and subsequent amendments/enhancements if any in respect of certain common items of expenditure.
12. He will inspect each divisional office once a year and report there on to the Chief Engineer. During his inspections, he will examine the divisional registers and other accounts, measurement books, the mode of preparation of estimates, contractor accounts and agreements, the system of recording plans and papers and office work generally. He is expected to communicate freely and personally with Executive Engineers and to advice them in the performance of their duties. (Para 13, 14, 16 & 17 of A.P.PWD Code)
13. Superintending Engineers have power to sanction the dismantlement of State Government buildings when the book value of the building does not exceed Rs.5000/-. Also the Superintending Engineer have powers to make a sale of dismantled materials the book cost of which do not exceed Rs.5000/- (Para 235, of A.P. PWD Code)
14. He can write off the loss of M. Books.

Functions to be discharged by Executive Engineer

Field Functions

1. He is answerable to the Superintending Engineer for the timely execution, maintaining quality and for proper management of works and accounts and for administration of his division (Para 25 of A.P PWD Code).
2. Evaluation of works connected with enquiries. Site inspection of works before according technical sanction

3. To inspect all the works before effecting final payment to satisfy himself about quality & quantity as a paying officer. He should inspect all major & important items of works such as concrete, black topping, etc., when they are in progress.
4. He should be regular in his touring and has to chalk-out tour programmes well in advance and attend to the fieldwork systematically. He should review progress of works with subordinate engineers and sort out field problems during the field visits. He has to offer his remarks in site inspection books maintained during inspection of works and also submit his inspection reports to Superintending Engineer.

Desk Functions

1. To enter into agreement with the contractors for execution of works and communicate copy to Dy. Executive Engineer and/or Assistant Engineer/Assistant Executive Engineer concerned.
2. He should not sanction advances indiscriminately. If advancing of funds is unavoidable as per rules it should be limited to the cash flow requirement for the next fifteen (15) days and no second advance should be sanctioned before the previous advance is adjusted.
3. He has to follow the following course of action to recover the outstanding advances against officers, if any.
4. Issuing show cause notice to the individual and if necessary issuing the recovery proceedings duly following the revised CCA rules.
5. Articles of charge should be prepared and served to the individual. Procedure for imposing penalties shall be as per rule 20 of AP CCA rules.
6. Lodging police complaint and action under relevant provisions of IPC & Cr Pc.
7. At the time of transfer, pending imprests/advances should be noted in the LPC.
8. Sanctioning payments of petrol and oil bills for the jeeps under the use ofthe Executive Engineer
9. Distribution of contingencies and budgets with reference to Travelling Allowance among the subordinate office staff.
10. The Executive Engineer may transfer sub-ordinates (other than sub-divisional officer) born one station to another within the respective division without reference to the superior authority. The transfer will be reported to the Superintending Engineer. (Para-20 of APPWD code)
11. Pensions
    a. Sanction of the pensions of all Non-Gazetted officers including class-IV employees of his office and division.
    b. Forwarding the pension papers of all the Gazetted officers in his division to the Chief Engineer (TW) through Superintending Engineer concerned. (G.O.Ms.No.262, dt.23.11.98 of Fin. &Plng. (FW.PSC) Dept.)
12. On a work being finalised, it will be the duty of the Executive Engineer to close the accounts of it and to prepare the completion report as required by the rules in para 216 of APPWD Code and get it approved by competent authority. (Para-32 of APPWD code)

13. The Executive Engineer will furnish his office accounts to the audit officer under the rules in force and will exercise efficient control over his Divisional Accounts Officer (Works). The Executive Engineer is responsible for the correctness of the records of cash and stores, receipts and expenditure and for the submission of complete vouchers.
14. Furnishing replies to all audit paras and PAC paras raised on the functioning of his office and sub-ordinate offices.
15. He should not deviate from the estimates sanctioned by Superintending Engineer and Chief Engineer, without prior orders in writing.
16. To intimate the changes needed if any during execution based on local conditions and preparation & submission of working estimates to the competent authority.
17. The Executive Engineer is primarily responsible for reporting without delay, supported if necessary, by a work slip, the probability of any excess over the estimates, all important liabilities not brought to account being noted and for the prompt revision of estimates when necessary.
18. The Executive Engineer is responsible that the Surveying and Mathematical instruments in his division are properly cared, and will report of their condition, to the Superintending Engineer at the end of each working season, Any injury/damage to the instruments is due to negligence or carelessness should be made good at the expanse of the officer or subordinate responsible for the damage
19. He should submit all periodicals and work wise progress reports on all schemes before 10th of every month in duplicate to Superintending Engineer.
20. He is responsible for optimum utilisation of departmental machinery under his control and submit monthly returns to Superintending Engineer. The Executive Engineer is solely responsible for the economical operations of the departmental machinery and to keep thorn in working condition at all times. He should ensure that the monthly consumption figures of consumables for the T&P are certified by the Dy. Executive Engineer concerned and watch any deviations. He is also responsible for proposing condemnation of uneconomical or unserviceable. He has to ensure that the profit and loss account of tools & plants does not run into loss.
21. The should conduct physical verification of stock annually. He should obtain material at site account from all the Deputy Executive Engineers and submit consolidated M.A.S. account to the Superintending Engineer every month before 10th. He is responsible for proper inventory control of the materials (departmentally supplied) required in execution of works under his jurisdiction
22. He is competent to allocate work to the Assistant Engineers/Assistant Executive Engineers in the sub-divisions.
23. He should send one estimate sanctioned by him per month to the Superintending Engineer for test chock similarly he should obtain from his Dy. Executive Engineer one estimate per month sanctioned by him for test check.

24. He will maintain all records & registers prescribed for the division.
25. The Executive Engineer is responsible for the purchase of stores, subject to the provisions of the store rules.
26. Sanction of Earned leave to the AEs/AEEs up to 3 months and to any extent to lower staff and his office staff as per eligibility. (G.O.Ms.No.38, dt.14.3.1985 of SW (V) Dept.)
27. The Executive Engineer is responsible for the correctness of engineering features and designs and for the rates allowed in estimates prepared or sanctioned by him.
28. The Executive Engineer is responsible to call for quotations, approve the lowest rate and communicate to various sub-divisions under intimation to the Superintending Engineer for those items not covered by SSR.
29. To initiate disciplinary action on all the erring officials as per A.P.Civil Services (CCA) rules.
30. To train the staff for development of Human Resources in the division.
31. To guide the Deputy Executive Engineers in the matter of works programme and accounts.
32. To initiate proposals for additional staff when ever required.
33. Reconciliation of departmental figures with those of Treasury and to obtain certificate from the Treasury and to send the certified figures to Superintending Engineer & Chief Engineer every month.
34. To submit statement of expenditure and balances every month to Project Officer, ITDA and Superintending Engineer.
35. Registration, issue and maintenance of account of M. Books.
36. The is responsible for timely adjustment of releases under various schemes and proper accounting of grants and their revalidation. He should spend all grants released to his division before lapsing date and submit Utilisation Certificates promptly.
37. To refund the deposits to the eligible contractors.
38. To submit reports on LAQs/LSQ/RSQ and Assurances on the Floor of the Assembly.
39. Conducting monthly reviews with the DEEs & AEEs/AEs & take suitable measures for timely completion of schemes.
40. Submission of information required by Government, Chief Engineers, Superintending Engineer and P.O., ITDA from time to time.
41. He has to attend meetings convened by the District Authorities.
42. He has to attend the meetings convened by Project Officer (ITDA), Superintending Engineer and Chief Engineer.
43. Issue of Inspection reports on the works inspected during the field visits.
44. To maintain quarry charts and Road Metal Rate Books.
45. Preparation of annual Budget for all staff in the division and all works programme in his jurisdiction to be submitted to P.O., I.T.D.A. and Superintending Engineer.
46. Submission of Utilisation Certificates for the grants received.
47. Submission of Annual Administrative Report of the division. Payment of pay and allowances to staff working in his division.

48. Sanction of annual increments to the staff in his office and up to Deputy Executive Engineer level. He is responsible for all payments including work bills.
49. He is technical advisor to the Project Officer, 1. T. D.A. concerned. To prepare plan of action to be included in five year plan and annual plans in respect of all types of works being executed by the division.
50. The Executive Engineer is prohibited form commencing any work or incurring expenditure of any public funds without the sanction by the competent authority or from making any deviations from sanctioned designs in the course of execution, except in case of emergency
51. Sending proposals to the competent authority and obtaining extension of time on the agreements of works which are not completed within the prescribed time.
52. The following course of action is to be followed in case of surplus materials to be recovered from the contractors or any outstanding recoveries to be effected for fraud.
    a. Initiate action as contemplated at Part II of G.O. 521, dt.10.12.1984 of Irrigation Dept. On the contractor.
    b. Lodging Police complaint for loss
    c. Address sister-engineering departments to recover from bills/deposits due to them. In case of non recovery, addressing Revenue department for recovery under R.R.Act.
53. He is responsible for sending reply in 10 days to the notices given by the contractor.
54. Unit officer for ministerial staff for all the posts below the rank of Sr.Assistants in divisional Office & Sub-ordinate offices. (G.O.Ms.No.114 dt.3-12-99 of Social welfare (TW Ser-II) Dept.)

Statutory Functions

1. Registration of class III Contractors. (G.O.Ms.No.65, dt.3.7.99 of Social Welfare)
2. According technical sanction to original estimates, revised estimates and working estimates costing up to Rs.10.00 lakhs. (G.O.Ms.No.65, dt.3.7.99 of Social Welfare)
3. Calling Tenders of works costing up to 10.00 lakhs. (G.O.Ms.No.65, dt.3.7.99 of Social Welfare)
4. Accepting the tenders up to 15% excess overestimated rates for the works costing up to Rs.10.00 lakhs. (G.O. Ms. No. 65, dt.3.7.99 of Social Welfare) 5. Passing excess expenditure up to 5% above the technical sanction amount of the work subject to the limit of technical sanction powers. (G.O.Ms. No. 83, dt.1.4.85 7 of Social Welfare)
5. Passing excess expenditure on all works irrespective of total sanctioned estimate amount, without percentage limit is Rs. 2,000/- (G.O.Ms. No.83, dt.17.4.85 of Social Welfare)
6. The Executive Engineer has no powers to sanction excess in case of estimates sanctioned by the higher authority. (G.O.Ms.No.83, dt.17.4.85 of Social Welfare)
7. The Executive Engineer has no powers to sanction excess in case of estimates sanctioned by the higher authority. (G.O.Ms.No.83, dt.17.4.85 of Social Welfare)
8. Can accord technical sanction to detailed estimates up to 10% over administrative sanction subject to the limit of powers of technical sanction. (G.O.Ms.No.83, dt.17.4.85 of Social Welfare) • Technical sanction of electrical estimates to buildings up to Rs. 30,000/-. Can dispense with tenders (power of nomination) up to Rs. 1000/- for electrical estimates. Can

accept tenders of electrical estimates up to Rs. 50,000/-. (Annexure-III of Section No.11 of Executive Instructions of A.P. PWD Code and G.O.Ms.No.1007, dt.5.11.76 of T R & B Dept.)

9. Exercising the Financial Powers delegated by Govt., in G.O.Ms.No.148 dt.21.10.2000 of Fin & Planning (FW : ADMN. 1. TFR) Dept. and subsequent amendments/enhancements if any in respect of certain common items of expenditure.
10. Annual Inspection of Sub-Division offices to bring out lapses or irregularities in functioning of office through a detailed note to be communicated to the concerned for rectification in order to streamline the functioning of office.
11. Check measure/Super check measure a minimum of 48 number of works in an year and while doing so, important items like foundations, reinforcements of RCC works, BT works etc., should be included.
12. Executive Engineer has power to sanction the dismantlement of State Government buildings when the book value of the building does not exceed Rs. 1000/-. Also the Executive Engineer as powers to make a sale of dismantled materials the book cost of which do not exceed Rs. 1000/-. (Para 235, of A.P. PWD Code)

Functions to be discharged by Deputy Executive Engineer

Field Functions

1. He should be regular in his touring, he has to chalk-out a monthly tour programme well in advance and attend to the field work systematically.
2. He should review progress of works with sub-ordinate engineers and sort out field problems during field visits. He has to offer his remarks in site inspection books maintained during inspection of works. He has to check the mark out, supervise the execution of works in accordance with the sanctioned estimate, agreement concluded, Andhra Pradesh Detailed Standard Specifications (APDSS), AP PWD code and other circular instructions Stan issued by higher officers and Government from time to time.
3. He has to ensure quality of raw materials used and good workmanship in execution and finished items of works. He should not deviate any sanctioned item of work without prior permission in writing from the competent authority.
4. He should be present at the time of executing critical components of the work SLIC11 as Foundation concrete, RCC, WBM Consolidation, Black topping of ST roads, etc. and he is responsible for timely execution and for maintaining the quality in the execution of works.
5. For all major works costing beyond Rs.1,00,000/- he should personally check the mark out.

Desk Functions

1. He will manage the execution of works efficiently in the sub-division.
2. He will exercise administrative control over the staff in the sub division.
3. He will scrutinize the final work bill received from AEEs/AEs for the works completed and submit to higher office for arranging final payment along with the completion reports. For the works completed up to an acceptable stage, he has to scrutinise part bills received from the AEEs/AEs and submit to higher office for arranging part payment.

4. Preparation of time schedule covering all activities of the work, for it's execution within the time stipulated in the agreement for completion of work and enforcing them.
5. He has to monitor the progress of works and issue notices to contractors with reference to the clauses and conditions of the agreement and clause 60 of AP DSS, if the contractor fails to start the work with in the stipulated time or fails to maintain the stipulated rate of progress and report to Executive Engineer. He should promptly reply to the notices from the contractors.
6. He is responsible for correctness and proper maintenance of Road Metal Rate books & Quarry charts.
7. He is responsible for extracting the work from the Work-charged establishment.
8. He will get the maintenance estimates prepared by AEE/AE for all the departmental assets under his jurisdiction and submit to the higher office (E.E) every year for necessary approvals and sanctions.
9. He will appraise the progress in execution of works to the EE and SE periodically through progress reports, in the meetings convened, and during field visits. He has to bring out field problems, if any in the execution of works during the field visits of EE and SE.
10. Submission of information required by Chief Engineer, Superintending Engineer, Executive Engineer, and Project Officer from time to time.
11. He is responsible for the proper maintenance of accounts like material at site account, 7F account, etc., and for submission of basic periodical returns relating to the accounts, progress of works, etc. He is responsible to bring to the notice of the E.E. about the materials that are not in use for the last 6 months.
12. He will arrange the supply of materials that are supplied by the department to the contractors.
13. He is responsible for reporting the unutilized/surplus material if any in the sub-division to his Executive Engineer. He is responsible for utilising the material received by him within 3 months in his sub-division. He is responsible for assessing the requirements of materials well in advance and submitting to Executive Engineer.
14. He will furnish the required records to the Audit authorities as and when they are requested by the Audit party during audit inspection of Sub-Division/Division.
15. He will maintain registers indicated in subsequent chapter-11.
16. He should discharge any other official duty entrusted by his superior officers.
17. Maintenance of DLR's and monthly returns of Tools and Plants under his control
18. Submission of proposal to the Executive Engineer for extension of time to the agreements of works which are not completed with in the prescribed time.
19. To recommend recoveries for the departmental materials, hire charges from the work bills and other recoveries due to the Government to be effected from the contractor’s bills.
20. To submit reports on LAQs, LSQ, RSQ & Assurances on the floor of the legislative Assembly.
21. To prepare plan of action to be included in Five Year Plan/Annual Plans in respect of all types of works being executed in his sub-division.
22. Preparation of Budget for the staff and works programmes in his jurisdiction and submit to E.E

23. He has to keep a watch on advances given to the Section officers in his sub-division.
24. After the competent authority accords administrative sanction the DEE has to get the Designs, Drawings & the detailed estimates prepared by AEE/AE, check them and submit to the higher office within the stipulated time for according technical sanction by competent authority. The Sub-Divisional Officer can grant leave (other than special disability leave) to work charged estt., up to one month at a time as per Para 50 of APWD Code,
25. He is responsible for spending all the grants allotted to him and to spend the estimated cost on each works before the lapsable date.
26. He is responsible for reporting to the Executive Engineer, any deviations/revisions needed in the sanctioned estimates during execution based on local conditions for his orders. He prepares and submits working estimate to the Executive Engineer for the same.
27. He should conduct physical verification of the store every quarter. He is responsible to obtain and submit M.A.S. accounts to the Executive Engineer, before 5th of every month.
28. He should dispose off references received by the sub-division in 10 days.
29. He should keep himself abreast of various new developments in his field and regularly study Engineering books, journals, magazines, codes and the various technical papers.
30. He should take initiative in all matters and develop a spirit of self-confidence and be in a position to instruct and guide his subordinates boldly, correctly and unhesitatingly.
31. Conducting monthly reviews with sub-ordinates and issue instructions for timely completion of schemes. To guide the Section Officers on the matters of works programmes.
32. Preparation of annual account of profit and loss of T&P.
33. To initiate pension and gratuity papers for work charged establishment.
34. Payment of salaries to staff working in his sub-division, including work charged stablishment. To attend meetings of EE, SE & PO, ITDA
35. He is responsible for optimum utilization of machinery and Tools & Plants under his control.

Statutory Functions

1. He will check measure the measurement recorded by AEE/AE in M.Book promptly, after the work reaches a desired level or is completed. He has to check measure the premeasurement for reinforcement of RCC works recorded by AEE/AE in M.Books before laying concrete.
2. He will submit M.Books of the works to Executive Engineer after the check measruements and also whenever required by the Executive Engineer.

Functions to be discharged by Assistant Executive Engineer/Assistant Engineer

Field Functions

1. In case of breach of roads it is the duty of AEE/AE to form diversion roads to avoid hindrance to the traffic.
2. He is responsible for removing the rejected material from the site in case the contractor fail to remove within 24 hours in compliance to the written instructions of Executive Engineer concerned at contractors expenses (P.S Para 27 of A.P.D.S.S)

Desk Functions

1. He will prepare the final work bill for the works completed and submit to higher office for arranging final payment along With the completion reports. For the works completed up to an acceptable stage, he has to prepare part bills and submit to higher office for arranging part payment.
2. Preparation of time schedule covering all activities of the work, for it's execution with in the time stipulated in the agreement for completion of work & enforcing the same.
3. He has to monitor the progress of works & issue notices to contractors with reference to the clauses & conditions of the agreement and APDSS, if he fails to start the work with in the stipulated time or if he fails to maintain the stipulated rate of progress of work and report the same to DEE and EE.
4. He is responsible for correctness and proper maintenance of Road Metal Rate books and Quarry charts. He should keep site inspection books (P.S. 57 of APDSS).
5. He should invariably make available an attested copy of estimate, agreement, M.Books and the work file for verification during the field inspection of higher authorities.
6. Exercise control over work inspectors under his control. Allocate work, fix u targets and extract required out turn from them.
7. He will prepare maintenance estimates for all the departmental assets under his jurisdiction and submit to the higher office (DEE) on or before first of February of every year for necessary sanctions.
8. He has to appraise the progress in execution of works to the DEE and EE periodically by progress reports, in the meetings convened, and during field visits. He has to bring out field problems, if any faced by him in execution of works during the field visits of DEE and EE.
9. Submission of information required by Chief Engineer, Superintending Engineer, Executive Engineer, Dy. Executive Engineer and Project Officer.
10. He is responsible to utilise the materials drawn by him within 3 months.
11. He is responsible for the proper maintenance of accounts like material at site account, 7F account, etc., and for submission of basic returns relating to the accounts, machinery, progress of works, etc,
12. He has to submit (1) Return of pages used in M, Books (2) Return of works to be checkmeasured by DEE and 3) Return of receipt and issue of materials before 2 nd of every month positively.
13. He is responsible to bring to the notice of the DEE about the materials which are not in use for the last 6 months.
14. He has to furnish the required records such as Registers, M. Books, etc., to the Audit authorities as and when they are requested by the Audit party during audit inspection of Sub-Division/Division.
15. He has to maintain the registers as indicated in chapter 11

16. He should be regular in his touring and attend to the fieldwork systematically, spend maximum time in the field. He should camp on work spots for longer periods instead of frequently returning to head quarters.
17. He should keep himself abreast of the latest developments in engineering field by reading Engineering books, Journals & Periodicals.
18. He should discharge any other official duty entrusted by his superior officers,
19. Maintenance of DLR's of Tools and Plants under his control and for making optimum utilisation of machinery and Tools & Plants.
20. Submission of proposal to the Dy. Executive Engineer for extension of time to the agreements well in time, of works which are not completed with in the prescribed time.
21. Preparation of Muster rolls, their safe custody and payment of wages to the labour engaged.
22. To intimate the changes needed if any during execution based on local conditions and preparation of working estimate.
23. To recommend recoveries for the departmental materials and hire charges from the work bills and any other recoveries to be effected from the contractor.
24. To submit reports on LAQS, LSQ, RSO & Assurances on the floor of the legislative Assembly.

Statutory Functions

1. He has to record measurement of the works in M. Book timely, after the work reached to a desired level or completed and submit to the Deputy Executive Engineer for Checkmeasurement, duly following various codal requirements.
2. Functions to be discharged by Deputy Executive Engineer (Architecture)
3. Field Functions
4. Site visits for 1st hand evaluation of topography of site preparation of elevation of Buildings and planning.
5. Desk Functions
6. Preparation of Schematic / sketch plans.
7. Preparation of drawings/working drawings, i.e., Plans, Elevation, Sectional Details, Computing areas etc.
8. Preparation of detailed drawings of individual components like doors windows and other openings etc. • Preparation of exterior and interior details. Preparation of lay out plans, display drawings with suitable colouring.
9. Preparation of Electrical and Sanitary drawings. Preparation of Building views.
10. Detailed specification of materials used in buildings (shall be shown in drawings)
11. Develop drawings of avenue plantation on roads. Any other work that may be assigned by an appropriate authority

Functions to be discharged by Deputy Executive Engineer (Electrical)

Field Functions

1. The Dy Exe. Engineer (Elec) available at Hyderabad will be responsible to look after the maintenance of civil works & electrical fittings in Telugu SamkshemaBhavanam.
2. During inspection of electrical works he should guide the field staff in following the specification as per technically sanctioned estimates.
3. The Dy.Exe. Engineer (Elec) will also coordinate with Executive Engineer, Quality Control & Vigilance Division, Tribal Welfare, Hyderabad to attend to the checking of electrical works irrespective of cost and value of work as and when requested by the Executive Engineer, Quality Control & Vigilance Division so as to maintain and ensure the quality of electrical materials used in electrical works.
4. Desk Functions
5. He has to scrutinize the electrical estimates and tenders received from sub-ordinate offices for processing technical sanction.
6. He has to attend all correspondence related to electrical subject of respective offices.
7. He has to assist the Executive Engineer, Quality Control during his inspection in preparing the reports.
8. He should assist the field staff in preparation of electrical estimates of buildings.
9. Functions to be discharged by Technical Officer (Grade-1)

Desk Functions

1. Preparation and checking of detailed and preliminary estimates, excluding analysis of rates for non-schedule items, agreements depending on structural & service drawings.
2. Checking of revised estimates & supplementary agreements
3. Maintenance of account of survey and drawing instruments, office furniture etc.
4. Indenting drawing materials, custody of drawing materials and proper maintenance of their account.
5. Preparation of tender notice, schedules, safe custody of tenders, processing the result of tenders, preparation of agreements with successful tenders and custodian of all technical registers, etc.,
6. Any other work that may be assigned by an appropriate authority.
7. Preparatory work for data and price revisions in SSR meetings.
8. Processing the proposals of Extension of Agreement Time.

Functions to be discharged by Technical Officer (Grade-2)

Desk Functions

1. Preparations and checking of preliminary and detailed estimates.
2. Checking of revised estimates.
3. Maintenance of books, registers, records etc., relating to drawing branch.
4. Checking of all calculations M.Books with reference to survey records and drawings.
5. Handling drawing materials, custody of drawing materials and proper maintenance of their accounts.
6. Any other work that may be assigned by an appropriate authority.
7. All the duties of D.M – 1 when he works in divisions.

Functions to be discharged by Technical Officer (Grade-3)

Desk Functions

1. All the estimates with data will be scrutinized when the works in sub-division
2. Arithmetical checking of calculations, details of quantities etc., using computers if available.
3. Maintenance of drawing records, original plans of scheme etc.,
4. Arithmetical checking of estimates.
5. Comparing typed matter, estimates.
6. Copying of estimates, statements, analysis of rates etc.
7. Preparation of simple drawings from sketches.
8. Any other work that may be assigned by an appropriate authority

Functions to be discharged by Tracer

Desk Functions

1. Tracing of the drawings assigned to him by the appropriate authority and assists in preparing copies of tender schedule
2. Any other work that may be assigned by an appropriate authority

Functions to be discharged by Blue Print Operator

Desk Functions

1. Operation and proper upkeep of the Blue Print machine for taking out blue prints of the drawings assigned to him by appropriate authority and assist in preparing copies of tender schedules.
2. Any other work that may be assigned by an appropriate authority

Functions to be discharged by Executive Engineer (QC & Vigilance)

Field Functions

1. To conduct inspections at focal points in the field divisions of Tribal Welfare Engineering Department for clean, efficient and transparent functioning of the Department. (G.O.Ms.No.60, dt.27.4.93 of S.W. (VI) Dept.)
2. To check the quality of works as per the specifications prescribed and to report to the Chief Engineer. (G.O.Ms.No.60, dt.27.4.93 of S.W. (VI) Dept.)
3. To alert the executive staff and to condition and train them towards maintenance of quality in the works being executed and to guide field engineers. (G.O.Ms.No.60, dt.27.4.93 of S.W. (VI) Dept.)
4. To conduct enquiries on defective work of fraud in execution and to report to the Chief Engineer. G.O.Ms.No.60, dt.27.4.93 of S.W.VI) Dept.)
5. To conduct inspections at manufacturer's premises for clearance of materials indented by field officers confirming to the relevant standards/ specifications. (G.O.Ms.No.60, dt.27.4.93 of S.W. (VI) Dept.)
6. Watch procurement &utilisation of material by the Executive Engineers & Superintending Engineers including the procedure being followed at different levels.
7. To watch adherence of procedures & instructions and maintenance of prescribed registers at all levels.

Desk Functions

1. To generate detailed reports after inspection of works and submitting the same to the Chief Engineer, Tribal Welfare, Hyderabad. (G.O.Ms.No.60, dt.27.4.93 of S.W (VI) Dept.)
2. To generate detailed enquiry reports on allegations and submitting to the Chief Engineer, Tribal Welfare, Hyderabad. (G.O.Ms.No.60, dt.27.4.93 of S.W (VI) Dept.)
3. To appraise the Chief Engineer on the progress of implementation -of various schemes with special reference to quality, procedure being followed, state of maintenance of accounts, maintenance of prescribed registers and the need for changes in procedures or specifications if any.

Statutory Functions

1. Inspection of ongoing works at different stages and issuing inspection reports. (G.O.Ms.No.60, dt.27.4.93 of S.W (VI) Dept.)
2. Conducting enquiries on the allegations received and also referred to him by the Chief Engineer. (G.O.Ms.No.60, dt.27.4.63 of SIN (VI) Dept.)

Functions to be discharged by Dy. Exe./ Asst Exe. Engineer (QC & Vigilance)

1. The Dy. Executive Engineers and the Assistant Executive Engineers/Assistant Engineers in the Control and Vigilance Division have to assist the Executive Engineer in all his functions.

Functions to be discharged by Divisional Accounts Officer (Works)

Desk Functions

1. He should compile-accounts of the Division in accordance with the prescribed rules (Para 89 a (1) – 'A' Code. : Para 33, of. 'D-Code.)
2. He is required to inspect the accounts of the Sub-Divisional Offices, explaining the defects of procedure and issuing necessary instructions thereon to the Sub-Divisional Officers and their staff.
3. He is responsible for applying preliminary checks to the initial accounts, vouchers etc. (Para - 89 (a) (ii) - 'A' Code.)
4. He is expected to see that the rules and orders in force are observed in respect of all transactions of the Division which come within his sphere of duties.
5. If he considers that any transaction or order effecting the accounts of the Division is such that it would be challenged by the audit authorities, he should bring it to the notice of the Divisional Officer (EE)
6. When the Divisional Accounts Officer has been over ruled the Di visional Officer (EE) and if the D.A.O. is not satisfied with such decision of the Executive Engineer, though he is duty bound to comply with the orders of the Executive Engineer, he should make a brief note of the case in the register of objections, (Form 60) to be maintained by the D.A.O., and put up the register to the Executive Engineer so that the latter may have an opportunity either for accepting the advice of the D.A.O. on reconsideration and ordering action accordingly or for recording, for the information of the auditing authority, his reasons for disregarding the advice of the D.A.O.
7. The Divisional Accounts Officer is responsible for the arrangement for checking the tender documents and the agreements and he is the custodian of the original documents of all the agreements. (Para 158 of 'D' Code and G.O.Ms.No.1035, P.W.D dt.20.4.60)
8. The Divisional Accounts Officer is responsible to ensure that the payments are supported by valid vouchers etc. and are as per other financial rules. (Para 89 (a) (ii) & (iii) of 'A'-Code & Para 548 of 'A'-Code).
9. The Divisional Accounts Officer is responsible to monitor grant wise and work wise expenditures and for the submission of Utilisation Certificates promptly. Review of M. Books periodically. (Para 296 of 'A'-Code)
10. He is responsible for all corrections advised by A.G. are specially brought to the notice of Executive Engineer. (Para 579 of 'A' - Code). He is responsible for timely conduct of inspection of sub division offices. (Para 588 of 'A'-Code)
11. He is responsible for prompt submission of all periodicals and maintenance of prescribed registers and records at division level. He is responsible for overall administration of division

office and for all establishment and accounts matters. (Govt. DO.No.23973 – A/316/WA1/ A1/88, dt.23.9.98 of Fin. &Plang. Dept.) and (Para 571 of 'A'-Code.)

12. He is responsible for adherence of rules and procedures in the cases being dealt by the division and bringing to the notice of Executive Engineer any violations. (Para-100 (2) of 'ACode.)
13. He is responsible for prompt submission of 7F accounts and for watching the optimum utilization of machinery and Tools & Plants in the division.

1.4 : REGISTERS MAINTAINED BY THE FUNCTIONARY

SL.NO	Name of the register	Name of the fuctionary				
		CE	SE	EE	DEE	SO
1	Cash book	NO	NO	YES	YES	NO
2	Imprest cash Account	NO	NO	YES	YES	YES
3	Register of Cheque and Money orders	NO	NO	YES	YES	NO
4	Petty Cash Book	NO	NO	YES	YES	NO
5	Register of Advances recovered	NO	NO	YES	NO	NO
6	Register of Permanent Advances	YES	YES	YES	YES	YES
7	Grants Appropriation Register	NO	NO	YES	NO	NO
8	Acquittance Register of establishment	YES	YES	YES	YES	NO
9	Abstract register of receipts and expenditure	NO	NO	YES	NO	NO
10	Register of deposits	NO	NO	YES	NO	NO
11	Register of lapsed Deposits	NO	NO	YES	NO	NO
12	Register of Miscellaneous Demand	YES	YES	YES	YES	YES
13	Register of Cheque/Receipt Book	NO	NO	YES	NO	NO
14	Register of fruit bearing Avenues	NO	NO	YES	YES	YES
15	Unstamped receipt Book	NO	NO	NO	NO	YES
16	Treasury remittance Book of the engineer	YES	YES	YES	NO	NO
17	Transfer Entry Register	NO	NO	YES	YES	YES

18	Register of Works	NO	NO	YES	YES	YES
19	Contractors Ledger	NO	NO	YES	NO	NO
20	Register of Estimates Received	YES	YES	YES	YES	NO
21	Register of Estimates Technically Sanctioned	YES	YES	YES	NO	NO
22	Stock Register of M. Books	NO	NO	YES	YES	NO
23	Register of Agreements	YES	YES	YES	YES	NO
24	Tender Register	YES	YES	YES	YES	NO
25	Tender Schedules Register	YES	YES	YES	YES	NO
26	Register of Contractors	YES	YES	YES	NO	NO
27	Suspense A/C Register	NO	NO	YES	NO	NO
28	Register showing the Receipts issues and balance of Materials at Site Account	NO	NO	YES	YES	YES
29	Register of Receipts and Issues of balance of Material at site Account	NO	NO	YES	YES	YES
30	Annual Verification statement of Road metal and other Materials	NO	NO	YES	YES	YES
31	Register of Works Bills	NO	NO	YES	YES	YES
32	Register of Fixed Charges	NO	NO	YES	YES	YES
33	Register of Buildings	NO	NO	YES	YES	YES
34	Road Metal Rate books	NO	NO	YES	YES	YES

35	Register of Bridges and Culverts	NO	NO	YES	YES	YES
36	Register of Roads	NO	NO	YES	YES	YES
37	Register of Wells	NO	NO	YES	YES	YES
38	Register of P.W.S. Schemes	NO	NO	YES	YES	YES
39	Register of works check measured and super check Measured	NO	YES	YES	YES	NO
40	Register of Miscellaneous Recoveries	NO	NO	YES	YES	NO
41	Register of Miscellaneous Sanctions	NO	NO	YES	NO	NO
42	Roads Charts	NO	NO	YES	YES	YES
43	Register of MI Tank	NO	NO	YES	YES	YES
44	Monthly Log Book Heavy Tools and Plans	NO	NO	YES	YES	YES
45	Daily Log sheets Road Rollers/ Lorries	NO	NO	YES	YES	YES
46	Register of Hire Charges	NO	NO	YES	YES	YES
47	Register of Encroachments	NO	NO	YES	YES	YES
48	Covering List of engineering Vouchers	NO	NO	YES	NO	NO
49	Register of Miscellaneous Sales	NO	NO	YES	NO	NO
50	Paybill Register	YES	YES	YES	YES	NO
51	Treasury Pass Book	YES	YES	YES	YES	NO
52	Treasury Bill Book	YES	YES	YES	YES	NO
53	Establishment Audit Register	NO	NO	YES	NO	NO
54	Register of Probationers	YES	YES	YES	NO	NO
55	Register of Service Registers	YES	YES	YES	YES	NO
56	Detailed Book of Receipts and Expenditure	NO	NO	YES	NO	NO
57	Stock Account of Stationary	YES	YES	YES	YES	NO

58	Stock Account of Forms	YES	YES	YES	YES	YES
59	Stock Register of Tools and Plans and Office Furniture	YES	YES	YES	YES	YES
60	Attendance Register	YES	YES	YES	YES	YES
61	Log Book for Motor Vehicles	YES	YES	YES	YES	NO
62	Register of Audit Objections	YES	YES	YES	NO	NO
63	Stamp Account Books	YES	YES	YES	YES	YES
64	Dispatch Register (Outward)	YES	YES	YES	YES	YES
65	Inward Register	YES	YES	YES	YES	YES
66	Register of Grants from Central Government	YES	YES	YES	NO	NO
67	Register of LAQs	YES	YES	YES	YES	YES
68	Register of Assurances	YES	YES	YES	YES	YES
69	Register of CMP Cases	YES	YES	YES	YES	YES

References:

Functionary & Departmental Manuals for TW Engg Dept and Other Manuals Published by Dr MCR Human Resource Development Institute:: Hyderabad

1.5 : GENERATION OF DETAILED WORK PROGRESS REPORT

The work progress report generated by CGG(Centre for good governance) format used in the Tribal Welfare Engineering Department .This application used by the Microsoft XL and in this format total (54)columns are there for each and every work detailed information extract from this .In generaly progress report initially collect from the field staff and then Division office and then it is forwarded to the Chief engineer office .The information collected from the field staff by hard copy or mail.

The following information is filled by the staff in the CGG

1. Monitoring year
2. Spill over or new works
3. Department
4. Grant or Scheme
5. Head of Account
6. Head of the Department
7. DDO code
8. District
9. Assembly constituency.
10. Mandal etc..

CHAPTER-2 TENDER PROCEDURES AND CONTRACT ADMINISTRATION

2.1 Introduction

This specialized program covers critical post-award contract administration topical areas, including the applicable contract clauses and critical issues that routinely confront the parties during contract performance. Now that you've been awarded a federal government contract, government and contractor teams focus on completing the requirements of the contract. The government team focuses on managing costs, quality, meeting the contract schedule, and performance. The contractor team focuses on managing risk, compliance, performance, quality, costs, and profit.

Many issues and problems surface quickly during the contract administration phase. Both government and contractor personnel must understand their rights and obligations under the contract and how to approach difficult situations and resolve problems to the mutual benefit of both parties.

This training is designed to stimulate critical thinking and discussion on commonly encountered contract administration issues. The application of certain key clauses and recurring issues that arise during the contract will be emphasized throughout to reinforce the importance of contract administration to successful performance and compliance.

Construction Contract Administration is Essential for the Success of the Project. When construction personnel think of contract administration, it's usually in regard to documentation of daily activities occurring on the project. Often overlooked are those aspects of contract the Lend themselves to cause disagreement or develop into disputes. Learn how good contract understanding will help develop and effective and efficient approach to construction project administration.

2.2:Pre tender activities

In this topic, activities such as preparation of estimates, according of Technical Sanction, approval of NIT, Bid Document with Bill of Quantities, releasing of Tender Notice are involved.

It is the primary responsibility of the Assistant Executive Engineer / Assistant Engineer to prepare the estimate for which Administrative Sanction is accordedand Care shall be taken in mentioning the source and lead of the materials.

As per the powers delegated in GO Ms. 94 of I&CAD (PW-COD) Department Dt:- 01.07.2003, the following officers are competent to accord Technical Sanctions for the financial limits shown against them.

I. Executive Engineer's upto : Rs.10 lakhs.
II. Superintending Engineer's upto : Rs.50 lakhs
III. Chief Engineer's upto : value of the administrative approval.

On receipt of the estimates from the field officers, the above officers have to accord Technical Sanction to the estimates as per the delegation of powers.

On approval of the estimates, the NIT and Bid Document with Bill of Quantities is to be approved immediately by the Technical Sanctioning Authority.

After approval of the NIT and Bid Document with Bill of Quantities, Tenders are to invited as per the following:

a. For the works up to Rs. 50 lakhs the tender notice shall be published in District editions of two Telugu dailies with the largest circulation. For works costing more than Rs. 50 lakhs, the tender notices will be published in one Telugu daily and one English daily having largest circulation at the State level. To reduce the cost of each publication, the format for the tender notice in the newspaper shall be finalized by the Board of Chief Engineers so that the cost of the advertisement is kept to the minimum.

b. The tender schedules should contain not only the quantities but also the rates worked out by the Department and the amount for each item and the total value of the contract. The tenderer will not be required to quote item wise. He should indicate his willingness to do the work either at the estimated value of the work of at a percentage in excess of the estimated value of the work or at a percentage less than the estimated value of the work.

2.3.GUIDELINES ON TENDER SYSTEMS

The Government of Andhra Pradesh during the year 2003, have issued orders in G.O Ms. No.2 of Information Technology & Communications Department Dt. 15-01-2003 citing that "the Information Technology Act, 2000 provides legal recognition for transactions carried out by means of electronic data interchange and other means of electronic communication, commonly referred to as 'Electronic Commerce'. As a part of its e-Governance initiatives, Government of Andhra Pradesh has identified e-Procurement as one of the key thrust areas and has taken up e-Procurement project as one of the core IT initiatives. Government of Andhra Pradesh has selected a consortium led by M/s. C1 India as the partner to develop, operate and maintain e-market place for a pilot project initially covering four departments / agencies viz., Andhra Pradesh Technology Services Ltd (APTS); Andhra Pradesh State Road Transport Corporation(APSRTC); Commissionerate of Tenders (CoT) (covering Irrigation and Command Area Development Deptt. and Roads & Buildings Deptt.) and Andhra Pradesh Health Medical Housing & Infrastructure Development Corporation (APHMHIDC), and has entered into an agreement with M/s. C1 India on 17th June, 2002 in this regard."

The Government vide G.O.MS.No. 36 Irrigation and CAD (PW-COD) Department Dated 07-03 -2003, have issued orders as

a. As a Pilot project, the 'e' procurement shall be adopted in Irrigation, R &B Departments in respect of works coming under the purview of the Chief Engineers / Engineer –in – Chief / Commissionerate of Tenders, costing Rs. 1.00 Crore and above taken up with State Government funds (including NABARD, AIBP) and N H. Works costing above Rs. 1.00 crore, adopting the guidelines / procedures as indicated in the Annexure enclosed.

b. All the existing codal rules, G.Os executive instructions applicable to the processingof conventional tenders are all applicable to the bids to be procured through 'e' Procurement, except to the extent modified / revised in the guidelines enclosed.
c. In respect of works which are included in 'e' procurement tenders will not be received in the conventional method.
d. The other circles will be included in 'e' procurement when ever the works are identified for tendering.

Later on the Government vide G.O.Ms.No: 48 Social Welfare (SCP.II) Department Dated: 22 -8-2003 have also implemented the 'e' procurement tendering systems in Tribal Welfare Engineering Department and Social Welfare Engineering Department.

The Government vide GO Ms No 133 of I&CAD (PW.REFORMS) Dt:- 20.11.2004 haverestricted the Tender Premium from 10% Excess to 5% Excess.

In GO Ms No 142 of I&CAD (PW.REFORMS) Dt:- 20.12.2004, the Qualification criteria Para 10 of GO Ms. No 94 of I&CAD (PW) Dt:- 01.07.2003 is amended as modified procedure of collection EMD in the shape of Bank Guarantee will not be made applicable for the works costing of Rs. 50.00 Lakhs and below and Single Cover system shall be followed and the EMD shall be submitted with completed Tender Schedule.

In GO Ms. No 6 of I&CAD (PW.REFORMS) Dt:- 11.01.2005, the Government have further amended certain conditions such as

a. Furnishing of hard copies by the tenderers before opening of the technical bids is dispensed with
b. The technical bid evaluation of the tenderers may be done on the certificated / documents uploaded through online only towards qualification criteria furnished by them.
c. A minimum of 3 days time gap shall be maintained between opening of technical bids and financial bids.
d. The tenderer shall invariably furnish the original DD/BG to the tender inviting authority before opening the price bids either personally or through courier or by post and the receipt of the same within the stipulated time shall be the responsibility of the bidder. Department will not take any responsibility for any delay and non receipt.
e. The successful (L1) tenderer shall furnish the original hard copies of all the documents /certificates/statements uploaded by him before concluding the agreement.
f. The tenderers shall be required to furnish a declaration in online stating the soft copies uploaded by them are genuine. Any incorrectness / deviation noticed will be viewed seriously and apart from cancelling the work duly forfeiting the EMD, criminal action will be initiated including suspension of business.
g. Before concluding the agreement, the tender inviting authority shall ensure the genuinity of the DD/BG furnished by the bidder in online by deputing responsible departmental officers.

The Government vide G.O.Ms.No.6 of INFORMATION TECHNOLOGY & COMMUNICATIONS DEPARTMENT (eprocurement) Dt:- Dated: 28-02-2005 issues the following orders for implementation of Public Key Infrastructure in eProcurement application with digital certificates issued by APTS.

a) All the suppliers / contractors have to mandatorily log into eProcurement website through secure mode and authenticate all their electronic transactions using digital certificates (signing certificate – single key pair) obtained from APTS –Sub CA in compliance to Chapter III of IT Act 2000.

b) All the Officers of GoAP Departments / Corporations / Local Bodies delegated with powers to invite, open and approval of tenders shall mandatorily login to eProcurement site through secure mode using their digital certificates issued by APTS to carryout transactions in eProcurement platform.

a. The officers vested with tender opening powers shall obtain dual key pair digital certificates i.e., two digital certificates comprising a signing certificate and an encryption certificate.
b. All other officers shall obtain only one digital certificate i.e., signing certificate (Single key pair).
c. The cost of the digital certificates issued to the officers of GoAP departments / Corporations / Local bodies by the APTS will be met from the 'e-procurement fund' being managed by APTS.

c) All the GoAP departments / Corporations / Local bodies shall direct the suppliers/ contractors registered with them to obtain digital certificates from APTS on payment of requisite charges.

d) Henceforth, the tender inviting authorities shall incorporate the following clause in the tender conditions. "The bidder shall authenticate the bid with his digital certificate for submitting the bid electronically on eProcurement platform and the bids not authenticated by digital certificate of the bidder will not be accepted on the eProcurement platform."

e) The Service Provider of eProcurement services i.e., M/s C1 India Pvt. Ltd., shall complete the integration of IT act 2000 compliant PKI with eProcurement software supporting single packet, two packet and World Bank tender processes for works, goods and services.

The operationalisation of PKI enabled eProcurement application shall come into effect from 1st March 2005.

Lateron in GO Ms. No. 245 of I&CAD (PW.REFORMS) Dt- 30.12.2005, the Government has further amended a condition of the instructions issued in GO Ms. No 6 of I&CAD (PW.REFORMS) Dt:- 11.01.2005 stating that the Para 5(c) shall be read as "In case of Two Cover System a minimum of 3 days gap shall be maintained between opening of technical bids and price bids and in case of single cover system a minimum of 3 days time gap shall be maintained between bid submission closing date opening of tenders. Also a new condition was introduced as Para 5(h) that the Government has further decided that notwithstanding any existing provisions of the AP Public Works Department Code as well as other orders and executive instructions in force, if any tenderers fails to submit the hard copies of the DD/BG for EMD, DD for transaction fee, hard copies of uploaded documents within the stipulated time, the tenderer will be suspended / disqualified from participating in the tenders on e-procurement platform for a period of 12 months from the date of bid submission. The suspension of the tenderer shall be enforced by the e-procurement system.

Again the Government vide GO Ms No 174 of I&CAD (PW.REFORMS) Department Dt:- 01.09.2008 has further amended the following in respect to evaluation and other particulars

1. Submission of original Hard copies of the uploaded scan copies of DD/BG towards Earnest Money Deposit by participating bidders to the tender inviting authority before opening of the price bid be dispensed forthwith.
2. All the bidders shall invariably upload the scanned copies of DD/BG on e-procurement system and this will be the primary requirement to consider the bid as responsive.
3. The Department shall carry out the technical bid evaluation solely based on the uploaded certificates / documents, DD/BG towards EMD in the eprocurement system and open the price bids of the responsive bidders.
4. The Department will notify the successful bidder for submission of original hard copies of all uploaded documents. DD / BG towards Earnest Money Deposit prior to entering into agreement.
5. The successful bidder shall invariably furnish the original DD/BG towards Earnest Money Deposit, certificates/ documents of the uploaded scanned copies to the tender inviting Authority before entering into agreement either personally or through courier or post and the receipt of the same with in the stipulated date shall be the responsibility of the successful bidder. The Department will not take any responsibility for any delay in receipt / non receipt of original DD / BG towards Earnest Money Deposit. Certificates / Documents, from the successful bidder before the stipulated time. On receipt of documents, the Department shall ensure the genuinity of the DD / BG towards Earnest Money Deposit and all other certificates/ documents uploaded by the bidder in e-procurement system in support of the qualification criteria before concluding the agreement.
6. If any successful bidder fails to submit the original Hard Copies of uploaded certificates / documents DD / BG towards Earnest Money Deposit with in the stipulated time or if any variation is noticed between the uploaded documents and the hard copies submitted by the bidder, the successful bidder will be suspended from participating in the tenders on e-procurement platform for a period of 3 years. The e-procurement system would deactivate the user ID of such defaulting successful bidder based on the trigger / recommendation by the tender inviting authority in the system. Besides this, the Department shall invoke all processes of law including criminal prosecution of such defaulting bidder as an act of extreme deterrence to avoid delays in the tender process for execution of the development schemes taken up by the Government.

After the bifurcation of the erstwhile Andhra Pradesh state into Telangana State, the Government in GO Ms No 14 of I&CAD (REFORMS) Department Dt:-31.01.2015, has increased the monetary limits of the contractors.

1. Special Class : Up to any amount
2. Class-I : Up to Rs. 30.00 Crores
3. Class-II : Up to Rs. 6.00 Crores

4. Class-III : Up to Rs. 3.00 Crores
5. Class-IV : Up to Rs. 1.00 Crore
6. Class-V : Up to Rs. 50.00 Lakhs

Further in GO Ms No 66 of I&CAD (REFORMS) Department Dt:-20.04.2015, have further amended the conditions in tendering process and also the registration limits.

2.4.BID EVALUATION

Tenders will be accepted in Two Parts i.e. Technical Bid and Price Bid.

Bids shall remain valid for a period of 90 days from the last date for receipt of Bid.

During the above mentioned period no plea by the bidder for any sort of modification of the bid based upon or arising out of any alleged misunderstanding of misconceptions or mistake or for any reason will be entertained.

In exceptional circumstances, prior to expiry of the original time limit, the Bid Inviting Officer may request the bidders to extend the period of validity for a specified additional period. Such request to the Bidders shall be made in writing. A Bidder may refuse the request without forfeiting his E.M.D. A Bidder agreeing to the request will not be permitted to modify his Bid, but will be required to extend the validity of his E.M.D. for a period of the extension.

Before the Two days for submission of Bids, the Bid Inviting Officer may modify any of the Contents of the Bid Notice, Bid documents by issuing amendment / Addendum.

Any addendum/amendments issued by the Bid Inviting Officer shall be part of the Bid Document and it shall either be notified in the News Papers in which NIT was published or displayed in e-market place.

To give prospective Bidders reasonable time to take an addendum into account in preparing their bids, the Bid Inviting Officer may extend if necessary, the last date for submission of bids.

On opening of the Technical Bid, the Technical Evaluation will be done as per the conditions stipulated in the Tender Documents and NIT.

Bidders Eligible to Bid:

The Bidders who

Possess the valid registration in the class and category mentioned in the NIT and satisfy all the conditions therein.

are not blacklisted or debarred or suspended by the competent authority for what ever the reason, prohibiting them not to continue in the contracting business.

Have complied with the eligibility criteria specified in the NIT are the eligible bids.

Bidders Ineligible to Bid:

A retired officer of the Govt. of AP or Govt. of India and their under takings is not eligible for biding for a period of two years from the date of retirement without the prior permission of the Government.

The Bidder who has employed any retired officer as mentioned above shall be considered as an ineligible bidder.

The Bidder himself or any of his employees is found to be an employee who retired from Government/ Government undertakings and had not obtained permission from the Government for Biding or accepting the contractor's employment within a period of 2 years from the date of his retirement.

The Contractor or any of his employees is found at any time after award of contract, to be such a person who had not obtained the permission of the Government as aforesaid before submission of the bid or engagement in the Contractor's service.

Contractor shall not be eligible to bid for works in the division / circle where any of his near relatives are employed in the rank of Assistant Engineer or Assistant Executive Engineers and above on the Engineering side and Divisional Accounts Officer and above on the administrative side. The Contractor shall intimate the names of persons who are working with him in any capacity or are subsequently employed. He shall also furnish a list of Gazetted /Non-Gazetted, State Government Employees related to him. Failure to furnish such information bidder is liable to be removed from the list of approved contractors and his contract is liable for cancellation.

Note: Near relatives include

1. Sons, step sons, daughters, and stepdaughters.
2. Son-in-law, and daughter-in-law.
3. Brother-in-law, and sister-in-law.
4. Brothers and Sisters.
5. Father and Mother.
6. Wife / Husband.
7. Father-in-law and Mother-in-law
8. Nephews, nieces, uncle and aunts
9. Cousins and Any person residing with or dependent on the contractor.

During the Technical Bid Evaluation, the bid opening authority may call upon any bidder for clarification on the statements, documentary proof relating to the technical bid. The requestfor clarification and response thereto shall be in writing and it shall be only on the qualification information furnished by the bidder. The clarification called for from the bidders shall be furnished within the stipulated time, which shall not be more than a week and failure of which will be liable for disqualification and rejection of his Bid.

Even though the bidders meet the above qualifying criteria, they are liable to be disqualified / debarred / suspended / blacklisted if they have

a. Furnished false / fabricated particulars in the forms, statements and / annexures submitted in proof of the qualification requirements
b. Not turned up for entering into agreement when called upon.
c. Record of poor progress such as abandoning the works, not properly completing the contract, inordinate delays in completion, litigation history or financial failures etc.
d. Participated in the previous bidding for the same work and had quoted unreasonably high bid percentage and

e. Even while execution of the work, if found that the work was awarded to the Contractor based on false / fake certificates of experience, the Contractor will be blacklisted and work will be taken over invoking clause 61 of PS to APSS.

After approval of the Technical Bid Evaluation by the competent authority, the Price Bid of those successful bidders shall be only opened and the lowest bidder will be approved.

Selection of Bidder among the lowest & equally quoted bidders will be in the followingorders:

a) The bidder whose bid capacity is higher will be selected.
b) In case the bid capacity is also same the bidder whose annual turnover is more will be preferred.
c) Even if the criteria incidentally become the same, the turnover on similar works and thereafter machinery available for the work and then the clean track record will be considered for selection.

The Superintending Engineer will evaluate whether each Bidder is satisfying the eligibility criteria prescribed in the bid document and declares them as a qualified Bidder.

If the technical bid of a Bidder is not satisfying any of the eligibility criteria it will be rejected by the Superintending Engineer. However, the bid accepting authority detects any error in the evaluation of Bids by Superintending Engineer, the bid accepting authority while returning the bids may direct the Superintending Engineer, as the case may be, to re-evaluate the bids.

Process to be Confidential.

(a) Information relating to the examination, clarification, evaluation and comparison of Bids and recommendations for the award of a contract shall not be disclosed to Bidders or any other persons not officially concerned with such process until the award to the successful Bidder has been announced by the bid accepting authority. Any effort by a Bidder to influence the processing of Bids or award decisions may result in the rejection of his Bid.

(b) No Bidder shall contact the Superintending Engineer, or any authority concerned with finalization of bids on any matter relating to its Bid from the time of the Bid opening to the time the Contract is awarded. If the Bidder wishes to bring additional information to the notice of the Superintending Engineer, it should do so in writing.

(c) Before recommending / accepting the bid, the bid recommending / accepting authority shall verify the correctness of certificates submitted to meet the eligibility criteria and specifically experience.

(d) Bids will be finalized by the Executive Engineers / Superintending Engineers / Chief Engineers for the works costing up to Rs.2 Crores. The bids for the works costing more than Rs.2 Crores will be referred to COT along with technical bid evaluation for consideration. The Commissioner of tenders shall scrutinize the bids submitted by Engineer-in-Chief / Chief Engineer / Project administrators in accordance with the conditions stipulated in the bid document and in case any discrepancy of non-adherence to the conditions, the same shall be communicated which will be binding both on the bid concluding authority and contractor. In case of any ambiguity the decision taken by the COT on bids shall be final.

2.5. ISSUE OF LoA AND CONCLUDING AGREEMENTS

1. Signing of Bids.

(a) If the bid is made by an individual, it shall be signed with his full name and his address shall be given. If it is made by a firm, it shall be signed by an authorized partner (with proof) who shall also sign his own name, and the name and address of each member of the firm shall be given, if the bid is made by a corporation it shall be signed by a duly authorised officer who shall produce with his bid, satisfactory evidence of his authorization. Such bidding corporation may be required before the contract is executed, to furnish evidence of its corporate existence. Bids signed on behalf of G.P.A. holder will be rejected.

(b) The Bid shall contain no alterations or additions, except those to comply with instructions issued by the Bid Inviting Officer, or as necessary to correct errors made by the Bidder, in which case all such corrections shall be initialed by the person signing the Bid.

(c) No alteration which is made by the bidder in the contract form, the conditions of the contract, the drawings, specifications or statements / formats or quantities accompanying the same will be recognized; and, if any such alterations are made the bid will be void.

2. Award Criteria

a. The Superintending Engineer will award or recommend to the Competent bid accepting authority for award of the contract to the Bidder who is found Technically qualified as per the Bid conditions and whose price bid is lowest.

b. The bid accepting authority reserves the right to accept or reject any Bid or all bids and to cancel the Biding process, at any time prior to the award of Contract, without thereby incurring any liability to the affected Bidder or Bidders or any obligation to inform the affected Bidder or Bidders of the reasons for such action.

3. Notification of Award and Signing of Agreement.

(a) The Bidder whose Bid has been accepted will be notified of the award of the work by the Superintending Engineer prior to expiration of the Bid validity period by registered letter. This letter (hereinafter and in the Conditions of Contract called “Letter of Acceptance”) will indicate the sum that the Government will pay the Contractor in consideration of the execution, completion, and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the “Contract Amount”).

(b) When a bid is accepted the concerned bidder shall attend the office of the Superintending Engineer on the date fixed in the Letter of acceptance. Upon intimation being given by the Superintending Engineer of acceptance of his bid, the bidder shall make payment of the balance E.M.D., by way of Demand Draft or unconditional and irrevocable Bank Guarantee obtained from a Schedule Bank with a validity period of (36) Thirty six months, and sign an agreement in the form prescribed by the department for the due fulfilment of the contract. Failure to attend the Superintending Engineer office on the date fixed, in the written intimation, to enter into the required agreement shall entail forfeiture of the Earnest Money deposited. The written agreement to be entered into between the contractor and the

Government shall be the foundation of the rights and obligations of both the parties and the contract shall not be deemed to be completed until the agreement has first been signed by the contractor and then by the proper officer authorised to enter into contract on behalf of the Government.

(c) The successful bidder has to sign an agreement within a period of 15 days from the date of receipt of communication of acceptance of his bid. On failure to do so his bid will be cancelled duly forfeiting the E.M.D., paid by him without issuing any further notice and action will be initiated for black listing the bidder.

(d) The Successful Bidders who back out from entering into Agreement at the last minute, causing loss to the Government will be debarred for One Year from participating in the tendering process of any department of the Government besides forfeiture of the 1% EMD.

(e) In case a Successful Bidder of a Single Bid received backs out from entering into Agreement, the EMD will be forfeited but the period debarring him from participating in the tendering process of any department of the Government will be restricted to Six Months Only.

4. Corrupt or Fraudulent Practices

(a) The Government require that the bidders / suppliers / contractors under Government financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy, the Government

define for the purposes of the provision, the terms set forth below as follows:

(i) "corrupt practices" means the offering, giving, receiving or soliciting of any thing of value to influence the action of a Government official in procurement process or in contract execution: and

(ii) "fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Government and includes collusive practice among Bidders (prior to or after Bid submission) designed to establish in Bid prices at artificial non-competitive levels and to deprive the Government of the benefits of free and open competition.

(b) Will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question.

(c) Will blacklist / or debar a firm, either indefinitely or for a stated period of time, if at any time determines that the firm has engaged in corrupt or fraudulent practices in competing for, or in executing a Government Contract.

Furthermore, Bidders shall be aware of the provisions stated in the General Conditions of Contract.

2.6.DIFFERENT CLAUSES OF CONTRACT AGREEMENT

The Contractor shall employ the required Key Personnel One Graduate Engineer (Civil) and One Diploma Engineer (Civil) to carry out the functions stated in the Schedule or other personnel with the same qualifications as approved by the Engineer-in-charge. The Engineer-in-charge will approve any proposed replacement of Key Personnel only if their qualifications, abilities, and relevant experience are substantially equal to or better than those of the personnel listed in the Schedule.

Failure to employ the required technical personnel by the contractor the following amounts will be recovered from the contractor bills as the over head charges includes technical personnel at site. Amount that will be recovered Rs. 27000.00 Per month.

The technical personnel should be on full time and available at site whenever required by Engineer in Charge to take instructions.

The Contractor shall construct and Commission the Work in accordance with the specifications and Drawings.

1. Power Supply.

The contractor shall make his own arrangements for obtaining power from the Electricity dept., at his own cost. Thecontractor will pay the bills of Electricity Department for the cost of power consumed by him.The contractor shall satisfy all the conditions and rules required as per Indian Electricity Act 1910 and under Rule-45(I) of the Indian Electricity Rules, 1956 as amended from time to time and other pertinent rules.

The power shall be used for bonafide departmental work only.

2. Monsoon Damages:

Damages due to rain or flood either in cutting or in banks shall have to be made good by the contractor till the work is handed over to the Department. The responsibility of de-silting and making good the damages due to rain or flood restswith the contractor. No extra payment is payable for such operations and the contractor shall therefore, have to take all

necessary precautions to protect the work done during the construction period.

3. The works to be Completed by the Intended Completion Date:

The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the programme submitted by the Contractor, as updated with the approval of the Engineer-in-Charge, and complete the work by the Intended Completion Date.

4. Safety:

The Contractor shall be responsible for the safety of all activities on the Site.

5. Discoveries:

Anything of historical or other interest or of significant value unexpectedly discovered on the Site is the property of theGovernment. The Contractor is to notify the Engineer-in-charge of such discoveries and carry out the Engineer-in-Charge's instructions for dealing with them.

6. Possession of the Site.

The Department shall give possession of the site to the Contractor. If possession of a part site is given, the Department will ensure that the part site so handed over is amenable to carryout the work at site by the Contractor.

7. Access to the Site:

The Contractor shall provide the Engineer-in-Charge and any person authorised by the Engineer-in-Charge, access to the site and to any place where work in connection with the Contract is being carried out or is intended to be carried out.

8. Instructions:

The Contractor shall carry out all instructions of the Engineer-in-charge and comply with all the applicable local laws where the Site is located.

9. Settlement of disputes:

If any dispute of difference of any kind whatsoever arises between the department and the Contractor in connection with, or arising out of the Contract, whether during the progress of the works or after their completion and whether before or after the termination, abandonment or breach of the Contract, it shall in the first place, be referred to and settled by the Engineer-in-charge who shall, within a period of thirty days after being requested by the Contractor to do so, give written notice of his decision to the Contractor. Upon receipt of the written notice of the decision of the Engineer-in-Charge the Contractor shall promptly proceed without delay to comply with such notice of decision.

If the Engineer-in-Charge fails to give notice of his decision in writing within a period of thirty days after being requested or if the Contractor is dissatisfied with the notice of the decision of the Engineer-in-Charge, the Contractor may within thirty days after receiving the notice of decision appeal to the Department who shall offer an opportunity to the contractor to be heard and to offer evidence in support of his appeal, the Department shall give notice of his decision within a period of thirty days after the Contractor has given the said evidence in support of his appeal, subject to arbitration, as hereinafter provided. Such decision of the Department in respect of every matter so referred shall be final and binding upon the Contractor and shall forthwith be given effect to by the Contractor, who shall proceed with the execution of the works with all due diligence whether he requires arbitration as hereinafter provided, or not. If the Department has given written notice of his decision to the Contractor and no claim to arbitration, has been communicated to him by the Contractor within a period of thirty days from receipt of such notice the said decision shall remain final and binding upon the Contractor. If the Department fail to give notice of his decision, as aforesaid within a period of thirty days after being requested as aforesaid, or if the Contractor be dissatisfied with any such decision, then and in any such case the contractor within thirty days after the expiration of the first named period of thirty days as the case may be, require that the matter or matters in dispute be referred to arbitration as detailed below:-

Settlement of Claims:

Settlement of claims for Rs.50,000/- and below by Arbitration.

All disputes or difference arising of or relating to the Contract shall be referred to the adjudication as follows:

a) Claims upto a value of Rupees 10,000/-.
   - Superintending Engineer, of another circle of the department

b) Claims above Rs.10,000/- and up to Rupees 50,000/-.
   - Chief Engineer, of another department

The arbitration shall be conducted in accordance with the provisions of Indian Arbitration and Conciliation Act 1996 or any statutory modification thereof.The arbitrator shall state his reasons in passing the award.Claims above Rs.50,000/-.

All claims of above Rs.50,000/- are to be settled by a Civil Court of competent jurisdiction by way of Civil suit and not by arbitration.

A reference for adjudication under this clauses shall be made by the contractor within six months from the date of intimating the contractor of the preparation of final bill or his having accepted payment which ever is earlier.

10. Program:

The total period of completion is (12) Twelve months from the date of entering with agreement to proceed including rainy season. Keeping in view, the schedule for handing over of site work should be programmed such as to achieve the mile-stones as in "Rate of progress statement" enclosed. Mile stones will be drawn by the Superintending Engineer, in consultation with the executing agency at the time of concluding agreement

The attention of the bidder is directed to the contract requirement at the time of beginning of the work, the rate of progress and the dates for the whole work and its several parts as per milestones. The following rate of progress and proportionate value of work done from time to time as will be indicated by the Executive Engineer's Certificate for the value of work done and completion of milestones will be required. The date of commencement of their program will be the date of concluding agreement .

After signing the agreement, the contractor shall forthwith begin the work, shall regularly and continuously proceed with them.

Rate of progress:

Work programme of achieving the milestones (Statement).

Mile Stone – I	Site development and Completion up to Basement level for all components	(4) Months from start date.
Mile Stone – II	Laying of Roof slabs and completion of Brick work for all components	(8) Months from start date.
Mile Stone – III	Finishings of all components & Handing over	(12) Months from start date.

Site:- Schedule of programme of handing over site to the contractor.

The extent of portions of the site of which the contractor is to be given possession from time to time and the order in which such portions shall be made available to him and, Subject to any requirement in the contract as to the order in which the works shall be executed, the Superintending Engineer will, with the Executive Engineer's written order to commence the works, give to the contractor possession of so much of the site as may be required to enable the contractor to commence and proceed with the execution of the works in accordance with the programme if any, and otherwise in accordance with such

reasonable proposals of the contractor as he shall by written notice to the Superintending Engineer, make and will from time to time as the works proceed, give to the contractor possession of such further portions of the site as may be required to enable the contractor to proceed with the execution of the works with due dispatch in accordance with the said programme or proposals as the case maybe ; if the contractor suffers delay or incurs cost from failure on the part of the Superintending Engineer to give possession in accordance with the terms of this clause, the Engineer-in-Chief(TW) shall grant an extension of time for the completion of works.

The contractor shall bear all costs and charges for special or temporary way leases required by him in connection with access to the site. The contractor shall also provide at his own cost any additional accommodation outside the site required by him for the purposes of the work.

Subject to any requirement in the contract as to completion of any section of the works before completion of the whole of the works shall be completed in accordance with provisions of clauses in the Schedule within the time stated in the contract calculated from the last day of the period named in the statement to the bid as that within which the works are to be commenced or such extended time as may be allowed.

Delays and extension of time:

No claim for compensation on account of delays or hindrances to the work from any cause whatever shall lie, except as hereafter defined. Reasonable extension of time will be allowed by the Executive Engineer or by the officer competent to sanction the extension, for unavoidable delays, such as may result from causes, which in the opinion of the Executive Engineer, are undoubtedly beyond the control of the contractor. The Executive Engineer shall assess the period of delay or hindrance caused by any written instructions issued by him, at twenty five per cent in excess or the actual working period so lost.

In the event of the Executive Engineer failing to issue necessary instructions and thereby causing delay and hindrance to the contractor, the latter shall have the right to claim an assessment of such delay by the Superintending Engineer of the Circle whose decision will be final and binding. The contractor shall lodge in writing with the Executive Engineer a statement of claim for any delay or hindrance referred to above, within fourteen days from its commencement, otherwise no extension of time will be allowed.

Whenever authorised alterations or additions made during the progress of the work are of such a nature in the opinion of the Executive Engineer as to justify an extension of time in consequence thereof, such extension will be granted in writing by the Executive Engineer or other competent authority when ordering such alterations or additions.

11. Construction Programme:

The Contractor shall furnish within one month of the order of the work a programme showing the sequence in which he proposed to carry out the work, monthly progress expected to be achieved, also indicating date of procurement of materials, plant and machinery. The schedule should be such that it is practicable to achieve completion of the whole work within the time limit fixed and in keeping with the Mile stone programme specified and shall obtain the approval of the Engineer-in-

charge. Further rate of the progress as in the program shall be kept up to date. In case it is subsequently found necessary to alter this program, the contractor shall submit sufficiently in advance the revised program incorporating necessary modifications and get the same approved by the Engineer-in-charge. No revised program shall be operative with out approval of Engineer-in-charge.

The Superintending Engineer shall have all times the right, without any way violating this contract, or forming grounds for any claim, to alter the order of progress of the works or any part thereof and the contractor shall after receiving such directions proceed in the order directed. The contractor shall also report the progress to the Superintending Engineer within 7 days of the Executive Engineer's direction to alter the order of progress of works.

The Contractor shall give written notice to the Engineer-in-Charge whenever planning or progress of the works is likely to be delayed or disrupted unless any further drawings or order including a direction, instruction or approval is issued by the Engineer-in-Charge within a reasonable time. The notice shall include details of the drawing or order required and of why and by when it is required and of any delay or disruption likely to be suffered if it is late.

12. Speed of Work:

The Contractor shall at all times maintain the progress of work to conform to the latest operative progress schedule approved by the Engineer-in-Charge. The contractor should furnish progress report indicating the programme and progress once in a month. The Engineer-in-Charge may at any time in writing direct the contractor to slow down any part or whole of the work for any reason (which shall not be questioned) whatsoever, and the contractor shall comply with such orders of the Engineer-in-Charge. The compliance of such orders shall not entitle the contractor to any claim of compensation. Such orders of the Engineer-in-Charge for slowing down the work will however be duly taken into account while granting extension of time if asked by the contractor for which no extra payment will be entertained.

Delays in Commencement or progress or neglect of work and forfeiture of earnest money, Security deposit and withheld amounts.

If, at any time, the Engineer-in-Charge shall be of the opinion that the Contractor is delaying Commencement of the work or violating any of the provisions of the contract or Contractor is neglecting or delaying the progress of the work as defined by the tabular statement. "Rate of progress" in the Articles of Agreement", he shall so advise the Contractor in writing and at the same time demand compliance in accordance with conditions of Bid notice/bid document/ Agreement. If the Contractor neglects to comply with such demand within seven days after receipt of such notice, it shall then or at any time there after, be lawful for the Engineer-in-Charge to take suitable action in accordance with Clause.60 of APSS.

13. Suspension of works by the Contractor:

If the Contractor suspend the works, or sublet the work without sanction of the Engineer-in-Charge, or in the opinion of the Engineer-in-Charge neglect or fail to proceed with due diligence in the

performance of his part of the Contract as laid down in the Schedule rate of progress, or if he continue to default or repeat such default in the respects mentioned in clause.27 of the APSS Engineer-in-Charge shall take action in accordance with Clause 61 of APSS.

If the Contractor stops work for 28 days and the Stoppage has not been authorised by the Engineer-in-Charge the Contract will be terminated as per the existing instructions in vogue.

If the Contractor has delayed the completion of works the Contract will be terminated under Clause.61 of APSS.

14. Extension of the Intended Completion Date:

The Engineer-in-Charge shall extend or recommend for extension, in accordance with the Government orders in force, the Intended Completion Date if a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date.

The Engineer-in-Charge shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Engineer for a decision upon the effect of a Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

15. Delays Ordered by the Engineer-in-Charge:

The Engineer-in-Charge may instruct the Contractor to delay the start or progress of any activity within the Work.

16. Early Warning:

The contractor is to warn the Engineer-in-Charge at the earliest opportunity of the future specific events or likely circumstances that may adversely affect the Execution of Works.

The Contractor shall cooperate with the Engineer-in-Charge in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Engineer-in-Charge.

17. Management Meetings:

The Engineer-in-Charge may require the Contractor to attend a management meeting. The business of a management meeting shall be to review the programme for remaining work and to deal with matters raised in accordance with the early warning procedure.

2.7.GENERAL PRINCIPLES OF CLOSING CONTRACTS

1. Termination:

The Department may terminate the Contract if the contractor causes a fundamental breach of the Contract.

Fundamental breaches of Contract include, but shall not be limited to the following.

(a) The Contractor stops work for 28 days when no stoppage of work is shown on the current program and the stoppage has not been authorised by the Engineer-in-Charge.

(b) The Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation.

(c) The Engineer-in-Charge gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Engineer-in-Charge; and

(d) The Contractor does not maintain a security which is required and

(e) The Contractor has delayed the completion of works by the number of days for which the maximum amount of liquidated damages can be paid as defined.

(f) If the contractor, in the judgement of the Department has engaged in corrupt or fraudulent practices in competing for or in the executing the contract.

For the purpose of this paragraph: "corrupt practice" means the offering, giving, receiving or soliciting of any thing of value to influence the action of a public official in the procurement process of contract or execution. "Fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment to the Government and includes collusive practice among Bidders (prior to or after Bid submission) designed to establish Bid prices at artificial non-competitive levels and to deprive the Government of the benefits of free and open competition.

Notwithstanding the above the Department may terminate the contract for convenience.

If the Contract is terminated, the Contractor shall stop work immediately, make the Site safe and secured leave the Site as soon as reasonably possible.

2. Payment upon Termination:

If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Engineer-in-Charge shall issue a certificate for the value of the work done less advance payments received upon the date of the issue of the certificate, less other recoveries due in terms of the Contract, less taxes due to be deducted at source as per applicable law and less the percentage to apply to the work not completed. Additional Liquidated Damages shall not apply. If the total amount due to the Department exceeds any payment due to the Contractor the difference shall be a debt payable to the Department.

3. Property:

All materials on the Site, Plant, Equipment, Temporary Works and Works are deemed to be the property of the Department if the Contract is terminated because of Contractor's default.

4. Release from Performance:

If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Department or the Contractor the Engineer-in-Charge shall certify that the contract has been frustrated. The Contractor shall make the site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all works carried out before receiving it and for any work carried out after wards to which commitment was made.

5. Payment upon termination:

If the contract is terminated because of a fundamental breach of contract by the contractor, the Engineer-in-Charge shall issue a certificate for the value of the work done less advance payment received upon the date of the issue of the certificate and less the percentage to apply to the work not

completed as indicated in the contract data. Additional liquidated damages shall not apply. If the total amount due to the Department exceeds any payment due to the contractor the difference shall be a debt payable to the Department. In case of default for payment within 28 days from the date of issue of notice to the above effect, the contractor shall be liable to pay interest at 12% per annum for the period of delay.

2.8.COMPLETION OF WORK AND CLOSER OF CONTRACT

1. Completion:

The Contractor shall request the Engineer-in-Charge to issue a Certificate of completion of the Works and the Engineer-in-Charge will do so upon deciding that the work is completed.

2. Taking Over:

The Department shall takes over the Site and the Works within seven days of the Engineer-in-Charge issuing a certificate of functioning in good condition after defects liability period.

3. Final Account:

The Contractor shall supply to the Engineer-in-Charge a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The Engineer-in-Charge shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Engineer-in-Charge shall issue within 56 days a schedule that states the scope of the corrections or additions that are necessary. If the final Account is still unsatisfactory after it has been resubmitted, the Engineer-in-Charge shall decide on the amount payable to the Contractor and issue a payment certificate with in 56 days of receiving the Contractor's revised account.

4. Certificate of Completion of works:

When the whole of the work has been completed and has satisfactory passed any final test that may be prescribed by the Contract, the Contractor may give a notice to that effect to the Engineer-in-Charge accompanied by an undertaking to carryout any rectification work during the period of maintenance, such notice and undertaking shall be in writing and shall be deemed to be request by the Contractor for the Engineer-in-Charge to issue a Certificate of completion in respect of the Works. The Engineer-in-Charge shall, within twenty one days of the date of delivery of such notice either issue to the Contractor, a certificate of completion stating the date on which, in his opinion, the works were completed in accordance with the Contract or give instructions in writing to the Contractor specifying all the Works which, in the Engineer-in-Charge'' opinion, required to be done by the Contractor before the issue of such Certificate. The Engineer-in-Charge shall also notify the Contractor of any defects in the Works affecting completion that may appear after such instructions and before completion of the Works specified there in. The Contractor shall be entitled to receive such Certificate of the Completion within twenty one days of completion to the satisfaction of the Engineer-in-Charge of the Works so specified and making good of any defects so notified.

Similarly, the Contractor may request and the Engineer-in-Charge shall issue a Certificate of Completion in respect of:

a) Any section of the Permanent works in respect of which a separate time for completion is provided in the Contract, and

b) Any substantial part of the Permanent Works which has been both completed to the satisfaction of the Engineer-in-Charge and occupied or used by the Department.

If any part of the Permanent Works shall have been completed and shall have satisfactorily passed any final test that may be prescribed by the Contract, the Engineer-in-Charge may issue such certificate, and the Contractor shall be deemed to have undertaken to complete any outstanding work in that part of the Works during the period of Maintenance.

CHAPTER-3 INTRODUCTION OF GREEN BUILDING CONCEPTS IN TW ASHRAM SCHOOLS

3.1.1 Introduction:

A green Building uses less energy, water and other natural resources creates less waste & Green House Gases and is healthy for people during living or working inside as compared to a standard Building. Another meaning of Green Structure is clean environment, water and healthy living. Building Green is not about a little more efficiency. It is about creating buildings that optimize on the local ecology, use of local materials and most importantly they are built to cut power, water and material requirements. Thus, if these things are kept in mind, then we will realize that our traditional architecture was in fact, very green. Today, we have forgotten that how to make natural environment, instead copying it from developed countries.

Buildings are a major energy consuming sector in the economy. About 35 to 40% of total energy is used by buildings during construction. The major consumption of Energy in buildings is during construction and later in lighting or air-conditioning systems. This consumption must be minimized. Possibly, this should be limited to about 80-100 watts per sqm.

Energy conservation in building requires using energy-saving building materials in the design and construction of buildings, improving building insulation and sealing performance and enhancing the efficiency of heating systems to reduce energy consumption

Growing human activity has increased the concern for sustainability even more in recent times. Sustainability in the real estate context is not only limited to energy conservation, but also includes resource usage, impact on the neighbouring environment and working conditions for tenants. This concern has led to the development of green buildings. The green building concept broadly integrates many interests and aspects of sustainability emphasising reduction of environmental impacts through a holistic approach to land and building uses and construction strategies.

The overall benefits of green buildings mostly depend on the extent to which the sustainable features are addressed during the initial planning and design. A green building is most likely to succeed in its objective if sustainable features are envisioned and incorporated right at the design stage. The design has to take into consideration the entire supply chain-from material sourcing, energy modeling, resource reuse, civic amenities and waste disposal.

3.1.2 Definition of Green Building:

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to

design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building.

3.1.3 Impacts of the built environment:

Aspects of Built Environment:	Consumption:	Environmental Effects:	Ultimate Effects :
• Siting • Design • Construction • Operation • Maintenance • Renovation • Deconstruction	• Energy • Water • Materials • Natural Resources	• Waste • Air pollution • Water pollution • Indoor pollution • Heat islands • Stormwater runoff • Noise	• Harm to Human Health • Environment Degradation • Loss of Resources

Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

For example, green buildings may incorporate sustainable materials in their construction (e.g., reused, recycled-content, or made from renewable resources); create healthy indoor environments with minimal pollutants (e.g., reduced product emissions); and/or feature landscaping that reduces water usage (e.g., by using native plants that survive without extra watering).

The built environment has a vast impact on the natural environment, human health, and the economy. By adopting green building strategies, we can maximize both economic and environmental performance. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project. Potential benefits of green building can include.

3.1.4 Benefits of Green Building

a) Environmental benefits:

- Enhance and protect biodiversity and ecosystems
- Improve air and water quality
- Reduce waste streams
- Conserve and restore natural resources

b) Economic benefits:

- Reduce operating costs
- Create, expand, and shape markets for green product and services
- Improve occupant productivity
- Optimize life-cycle economic performance

c) Social benefits:

- Enhance occupant comfort and health
- Heighten aesthetic qualities
- Minimize strain on local infrastructure
- Improve overall quality of life

3.1.5 Green Building - Myths and Challenges

There are various myths regarding the green building implementation. One example is the myth that sustainability costs more, which ignores recent research as well as the reality that for any society to thrive and prosper, it must seek to create a healthy balance between its environmental, social, and economic dimensions as sustainability is not just about building green but building a healthy community and sustaining a quality of life.

Although green building has made tremendous strides in the past few years, there remain many who still are unconvinced of its benefits due to numerous myths and misconceptions floating around the main stream construction.

- Green buildings often lack the aesthetic quality of conventional buildings
- Green building products are often difficult to find
- Green building products do not work as well as the traditional ones
- Building green is too difficult and complicated
- It is difficult or not possible to convert existing conventional buildings into energy efficient buildings

In reality, it is proven that all these myths are the misconceptions of the people, all it needs it better implementation and educating the people about the concepts and contexts of building green.

3.1.6 Green Building Movement in India

The Green Building movement in India was triggered off when CIISohrabji Godrej Green Business Centre building in Hyderabad was awarded with the first and the prestigious Platinum rated green building rating in India. Since then, Green Building movement in India has gained tremendous impetus over the years.

With a modest beginning of 20,000 sq.ft. green built-up area in the country in the year 2003, today (as on 31 October 2019) more than 5,507 Green Buildings projects coming up with a footprint

of over 7 Billion sq.ft are registered with the Indian Green Building Council (IGBC), out of which 1,890 Green Building projects are certified and fully functional in India.

This growth has been possible with the participation of all stakeholders in the green building movement. Today all types of buildings are going the Green way- Government, IT Parks, Offices, Residential, Banks, Airports, Convention Centre, Institutions, Hospitals, Hotels, Factories, SEZs, Townships, Schools, Metros etc.,

3.2.1 Major Concepts of Green Building

While the practices or technologies employed in green building are constantly evolving and may differ from region to region, fundamental principles persist from which the method is derived: siting and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization and waste and toxics reduction. The essence of green building is an optimization of one or more of these principles. Also, with the proper synergistic design, individual green building technologies may work together to produce a greater cumulative effect.

3.2.2 Siting and structure design efficiency:

The foundation of any construction project is rooted in the concept and design stages. The concept stage, in fact, is one of the major steps in a project life cycle, as it has the largest impact on cost and performance. In designing environmentally optimal buildings, the objective is to minimize the total environmental impact associated with all life-cycle stages of the building project.

However, building as a process is not as streamlined as an industrial process, and varies from one building to the other, never repeating itself identically. In addition, buildings are much more complex products, composed of a multitude of materials and components each constituting various design variables to be decided at the design stage. A variation of every design variable may affect the environment during all the building's relevant life-cycle stages.

3.2.3 Energy efficiency

The most important element of green building is energy efficiency. Higher levels of energy efficiency reduce carbon emissions. The energy performance of a building depends on its design. It's massing and orientation, materials, building envelope, heating, ventilating, and air-conditioning (HVAC), systems, service hot water, lighting systems and controls determine how efficiently the building uses energy. The most effective way to optimize energy efficiency is to use an integrated, whole-building approach. Collaboration among all team members, beginning at project inception, is necessary in designing an energy-efficient building.

The building sector can significantly reduce energy use by incorporating energy-efficient strategies into the design, construction, and operation of new buildings and undertaking retrofits to

improve the efficiency of existing buildings. It can further reduce dependence on fossil fuel derived energy by increasing use of on-site and off-site renewable energy sources. Energy efficiency is generally the most cost-effective strategy with the highest return on investment, and maximizing efficiency opportunities before developing renewable energy plans will minimize the cost of the renewable energy projects needed.

Energy-efficient buildings allow for:

- **Enhanced working environment:** Healthier working environment include favorable lighting, acceptable sound levels, and thermal comfort and are affected by many energy-efficiency measures. An increasing number of surveys and studies show that natural light, proper ventilation, appropriate temperature and humidity ranges lead to healthier environments, increasing occupants well-being and productivity
- **Lower construction costs / faster payback:** through use of an integrated design process and project delivery, energy-efficient buildings can cost less to build than typical buildings. For example, optimizing the building envelope for the climate and designing an efficient electric lighting system can substantially reduce the size of the mechanical systems. Some energy-efficiency strategies may cost more up front, but the energy they save means they often pay for themselves within a few years.
- **Reduced operating costs:** Strategic up-front investments in energy efficiency measures provide significant long-term operating and maintenance cost savings.
- **Reduced greenhouse gas emissions:** electricity is most often generated by burning fossil fuels, whose combustion releases greenhouse gases such as carbon dioxide which contribute to climate change.

3.2.4 Water Efficiency

Buildings are significant users of the Earth's freshwater supply. The goal of a responsible building operator should be to encourage a smarter use of water, both inside and outside the facility. Indoor water use reduction is typically achieved through efficient plumbing fixtures, fittings, appliances.

Water efficiency is reducing water wastage by measuring the amount of water required for a particular purpose and the amount of water used or delivered. Solutions for water efficiency focus not only on reducing the amount of potable water used, but also on reducing the use of non-potable water where appropriate (i.e. flushing toilet, watering landscape, etc.). It also emphasises the influence consumers can have in water efficiency by making small behavioural changes to reduce water wastage and by choosing more water efficient products. Examples of water efficient steps includes fixing leaking taps, taking showers rather than baths, installing displacements devices inside toilet cisterns, males using urinals rather than toilet stalls, and using dishwashers and washing machines with full loads. These are things that fall under the definition of water efficiency, as their purpose is to obtain the desired result or level of service with the least necessary water.

Water efficiency normally relies on well-engineered products and fixtures like reduced water use dishwashers, or low-flow toilets and showerheads. Efficiency isn't an excuse to use more or to waste water. A conservation mindset helps ensure that there are adequate and sustainable water supplies for everyone well into the future. While water efficiency is important and it makes saving water automatic, it is still important to conserve water and not waste it because – now more than ever – every drop is precious. Efficiency isn't an excuse to use more or to waste water. A conservation mindset helps ensure that there are adequate and sustainable water supplies for everyone well into the future. While water efficiency is important and it makes saving water automatic, it is still important to conserve water and not waste it because – now more than ever – every drop is precious.

3.2.5 Material efficiency

Material efficiency is a description or metric which expresses the degree in which raw materials are consumed, incorporated, or wasted, as compared to previous measures in construction projects or physical processes. Making a usable item out of thinner stock than a prior version increases the material efficiency of the manufacturing process. Material efficiency goes hand in hand with Green building and Energy conservation, as well as any other ways of incorporating Renewable resource's in the building process from start to finish.

Building materials typically considered to be 'green' include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal and other products that are non-toxic, reusable, renewable, and/or recyclable. For concrete a high performance or Roman self-healing concrete is available.

3.2.6 Health and Comfort

People spend their lives mostly in the buildings. People spent 85 to 90 percent of 24 hours in indoor in a whole life. Therefore indoor air quality becomes a critical issue for the individual and public health. Poor indoor air quality and pollution can cause injury to occupants' health,it also influences their productivity and human beings' lives.

The indoor pollution can be caused by the building and materials which used for building decoration. It may damage people's health condition even more than outdoor pollutions. Nowadays, human has to suffer not only outdoor factors such as: noise, water pollution and motor vehicle pollution that result from global industrial development, but also the indoor environment pollution that comes from buildings and indoor decorative materials. 68% of diseases are related to indoor pollutions or poor indoor air quality, such as the aging of skin, hair shedding, general fatigue, forgetfulness, infertile, leukemia and cancer. Studies shows 37% of the respiratory diseases are caused by indoor environment. Also 22% of chronic disease, 5% of bronchial catarrh, 5% of cancers and 5% of leukemia are caused by indoor environment or indoor pollutions.

The source of indoor pollution

To ameliorate indoor air quality (IAQ) standards, WHO has established a comprehensive guideline. According to the guideline, indoor pollution comes from four main resources. The resources are as follow: building materials, household electrical appliances, heater and the soot from cooking. Buildings and decorative materials were cited as main sources of indoor pollution. Radioactive and chemical pollution are the main harms from these sources. Radioactive is released from decorative materials and elements such as brick walls, stones and concrete. Chemical pollution is released from textile, paint glue. Both of them can lead to cancer in long term and threat occupants' health especially children. Indoor chemical pollutant includes:

Benzene: Benzene in indoor air can originate from outdoor air and also from sources indoors such as building materials and furniture, attached garages, heating and cooking systems, stored solvents and various human activities. Materials used in interior design and construction are main contributors to indoor benzene concentrations.

Carbon Monoxide: Carbon monoxide can be found in every place. It is produced by cooking and heating as indoor resources and is also introduced from outdoor to indoor environment. In developed countries the main source of carbon monoxide emission is lack of appropriate cooking and heating ventilation system or poor maintenance and installation.

Formaldehyde: Formaldehyde Indoor sources may be ignition processes such as smoking, heating, cooking in the building. In the non-smoking buildings, formaldehyde originates from building materials such as furniture and wooden products containing formaldehyde-based resins such as particleboard, plywood and medium-density fiber board; insulating materials. The level of formaldehyde in indoor environment is related to level of humidity and high indoor temperature.

Other chemical factors such as Naphthalene, Nitrogen dioxide, Polycyclic aromatic hydrocarbons, Trichloroethylene and Tetrachloroethylene is found in indoor environment that may influence residents' health in negative side. To achieve healthier indoor environment, it is essential to eliminate or at least decrease source these chemical factors in the buildings.

3.2.7 Innovation Category

Three fourths of the world's energy is consumed in cities and more than half of it is consumed in buildings. The construction sector is one of the most traditional & cost oriented industries and it makes much sense to bring innovations that are environmentally and economically sustainable. Sustainability in the construction sector or in other words green buildings are mainly focused on the reduction of emissions, construction of energy efficient buildings and maintaining thermal comfort of the occupants. However we can further innovate to excel in terms of zeroed environment impacts and resource optimization. While adopting Innovation category in green buildings the major efforts should

be towards life cycle costing as to ensure minimum harm to environment throughout the operation cycle, resource recovery in order to use waste as a constructive resource.

For achieving the goal of significantly reducing the carbon footprint of buildings until the mid of this century, innovation for more effective policies, better financing opportunities, and broader sectoral approaches as well as context-tailored approaches on the city, neighbourhood and building level are needed. Hence there is a need to share existing innovations and to trigger diffusion of successful approaches. At the same time, we also need to identify the need for innovations which have not been realized to lead the way for innovative policy and decision makers to come up with new solutions to make the global building sector more climate friendly. Major innovations took place with the advent of green building concept.

3.3.1 Introduction to Green Building Rating system

A green building rating system is an evaluation tool that measures environmental performance of a building through its life cycle. Building rating systems are a popular tool to bring momentum in achieving energy efficiency and sustainability in buildings. It comprises a predefined set of criteria relating to the design, construction, and operations of green buildings.

Several rating systems for Green Building have been developed by various countries across the globe to rate the green buildings based on its degree of the environmental goals which have been achieved by them. In India, at present, there are predominantly two rating systems to certify buildings as green buildings, namely GRIHA and IGBC.

3.3.2 GRIHA

GRIHA or Green Rating for Integrated Habitat Assessment is a rating tool that assesses the performance of a building against certain nationally acceptable benchmarks. Developed by TERI and adopted by the Indian Government in 2007, it serves to carry out a qualitative and quantitative assessment and accordingly rate a building on its level of 'greenness'.

GRIHA currently operates under ADARSH (Association for Development and Research on Sustainable Habitats) and is supported by the National Advisory Council (NAC) and Technical Advisory Committee (TAC).

GRIHA performs the following activities regarding green Buildings

- Evaluate the environmental performance of a building over its entire life cycle.
- Provide a definitive standard for what constitutes a green building
- Follow best practices along with national and international codes applicable to the green design of buildings
- Achieve efficient resource utilization
- Enhance resource efficiency and better quality of life in buildings

GRIHA Criteria

The set of 34 GRIHA criteria are broadly classified into four categories:

- Site selection and site planning

- Building planning and construction
- Building operation and maintenance
- Innovation

These four categories are further classified into mandatory, optional, applicable and selectively applicable.

GRIHA Certification

All buildings in the design stage except for industrial complexes and housing colonies are eligible for certification under the TERI GRIHA system as follows:

POINTS SCORED	RATINGS
50 - 90	★
61 - 70	★★
71 - 80	★★★
81 - 90	★★★★
91 - 100	★★★★★

3.3.3 Indian Green Building Council (IGBC)

The Indian Green Building Council (IGBC) was formed by the Confederation of Indian Industry (CII) in 2001 The council is based out of the CII-Sohrabji Green Business Centre, Hyderabad which is India's 1st Platinum rated green building. The vision of the council is to enable a 'Sustainable built environment for all. IGBC is India's premier body for green building certification and related services.

Green projects rated by IGBC fall under one of the following levels (in ascending order): Certified, Silver, Gold and Platinum. Below is the list of rating systems by IGBC:

All the IGBC rating systems are voluntary, consensus based, market-driven building programmes. The rating systems are based on the five elements of the nature (Panchabhutas) and are a perfect blend of ancient architectural practices and modern technological innovations. The ratings systems are applicable to all five climatic zones of the country.

IGBC Green New Buildings rating system addresses green features under the following categories:

- Sustainable Architecture and Design
- Site Selection and Planning
- Water Conservation
- Energy Efficiency
- Building Materials and Resources
- Indoor Environmental Quality
- Innovation and Development

The guidelines detailed under each mandatory requirement & credit enables the design and construction of new buildings of all sizes and types. Different levels of green building certification are awarded based on the total credits earned. However, every green new building should meet certain mandatory requirements, which are non-negotiable.

The various levels of rating awarded are as below:

Certification Level	Owner-occupied Buildings	Tenant-occupied Buildings	Recognition
Certified	50 – 59	50 – 59	Good Practices
Silver	60 – 69	60 – 69	Best Practices
Gold	70 – 79	70 – 79	Outstanding Performance
Platinum	80 – 89	80 – 89	National Excellence
Super Platinum	90 - 100	90 - 100	Global Leadership

3.4.1 Identification of different Green building areas in School environment

Current status of TW Educational Institutions in Telangana:

The educational institutions comprises of Pre metric and Post Metric Hostels, Ashram Schools, Large Residential Schools, Working Women Hostels, Youth Training Centers, Vocational Training Centers, DR Deports, Godowns, Bus Shelters, etc. The health institutions are Anganwadi Centers, Sub Centers, Primary Health Centers etc. In each financial year, the department is spending about Rs 500 Crores towards creating of new infrastructure and considerable amounts towards operation and maintenance of the assets created already.

Most of the buildings in scheduled area districts are located in forest areas and need to be conserved. The factors of ventilation and illumination in the schools or hostels are a concern in providing enough living space for the inmates to maintain their health and hygiene. The ratio of openings in a room to its carpet area is a factor to be considered in apportioning the space for inmates.

The Tribal Welfare Institutions, both educational and health, in the state of Telangana are as detailed below:

Sl.No.	Sector	Institutions	No of Institutions
1	Primary Education	Primary Schools	1432
2	Secondary & Higher Education	Ashram Schools	319
		Hostels	143
		Mini Gurukulams	29
		Residential School Complexes	58
		Residential Junior Colleges	66
		Degree Colleges	22

3	Post Matric Scholar Support	Hostels	150
4	Skill Development Centers	Youth Training Centers	22
5	Health Institutions	Anganwadi Centers in 3 ITDA Areas (Approx.)	4956
		Sub Centers in 3 ITDA Areas	1652
		Birth Waiting Halls	10
		CHNCs	28
		Area Hospitals	5
		CHCs	12
		PHCs	93
6	Civil Supplies	Sub Depots	135
		MFP Godowns	5
		Daily Ration Depots	312
		Total	**9449**

The department has observed that the present cost of the buildings is working out to be around Rs 1,800 / - per square feet excluding taxes. It is essential to increase productivity and reduce cost of production for meeting the finance allocations of the state by effective trainings to help reduce the cost of production by using appropriate locally available raw materials without compromising safety of the structure. The Educational Institutions are located through out the state at approximately 850 locations. The power charges and water supply for these residential institutions are targeted to be reduced with the introduction of the Green Building concepts with energy efficient proposals.

3.4.2 Site selection and Planning

Site selection and design has an impact on issues as diverse as surrounding wildlife habitat and transportation options for building users. Location is a crucial component of green building practice, as how people and goods get to and from the site affects the environmental performance of the building and its occupants. Choosing a location that offers transportation options and a variety of nearby destinations:

The following are the goals of site selection and planning

- Protects air and water quality by reducing the distance people have to drive and making it easier to walk, bike, or take public transit
- Preserves open space, farmland, and natural lands by building on or near already-developed sites
- Saves money and resources by using existing infrastructure
- Give preference to brownfield sites and then identify an appropriate remediation strategy
- **Avoid developing inappropriate sites i.e. wetlands, virgin native ecosystems, or restored native ecosystems**
- Conduct a site survey to identify site elements and create a master development plan that will not harm the natural biotic community. Restoration practices should be incorporated into the plan.
- **Orient building in a manner that will maximize passive solar gain and natural lighting.**
- **Locate building in a manner that reduces erosion and contamination of other water.**

3.4.3 Sustainable water Practices

Sustainable water practices should provide adequate water quantity and appropriate water quality for a given need, without compromising the future ability to provide this capacity and quality.Reducing water consumption and protecting water quality are key objectives in sustainable building. One critical issue of water consumption is that in many areas, the demands on the supplying aquifer exceed its ability to replenish itself. To the maximum extent feasible, facilities should increase their dependence on water that is collected, used, purified, and reused on-site. The protection and conservation of water throughout the life of a building may be accomplished by designing for dual plumbing that recycles water in toilet flushing or by using water for washing of the cars. Waste-water may be minimized by utilizing water conserving fixtures such as ultra-low flush toilets and low-flow shower heads. Bidets help eliminate the use of toilet paper, reducing sewer traffic and increasing possibilities of re-using water on-site. Point of use water treatment and heating improves both water quality and energy efficiency while reducing the amount of water in circulation. The use of non-sewage and greywater for on-site use such as site-irrigation will minimize demands on the local aquifer.

We can Conserve finite freshwater resources and reduce utility by the following means

- Installing water-efficient appliances and plumbing fixtures
- Minimizing outdoor water use through landscaping techniques and efficient irrigation equipment
- Taking advantage of rainwater and greywater

Efficient use of water during construction

Construction industry needs huge water and almost 20% of its requirement can be reduced by effective building design construction and management.

The simple way to reduce water consumption during construction are given as under:

- Using buckets of water to clean the tools rather than running water. Water needed using the buckets manually will require significantly less water compared with running water. Sometimes high pressure hoses instead of running becomes faster with less use of water.
- Concrete mixers containing fly ash generally requires less water (1-10%) for a given slump than concrete containing Portland cement
- There are various methods of curing. Curing by ponding method is suitable for curing horizontal surfaces such as roof slabs or floors or pavements of highways
- This type of curing can reduce the demand for curing water. After placing the concrete, the surface is covered with moist canvass. After 24 hours these covers are removed and small ponds of sand are formed around the concrete slab. The area is divided into number of rectangles. The water is filled up between the ponds.

- Membrane curing is an important method of curing as it is water efficient. The concrete surface is covered by a layer of water proof material. The layer of water proof material is known as membrane. The membrane could be either in solid form or in liquid form. Thus it is a moist curing of concrete. The moist curing needs less water. Moist curing maintains the satisfactory temperature by preventing evaporation of the water. The sealing compounds used as membrane are wax emulsions, bitumen emulsion and plastic films. This method is employed at places where water is scarcely available. In India most of the contractors use dumps gunny bags for this purpose.

GRIHA recommends use of chemical admixtures such as High Range Water Reducers (HRWR) or super plasticizers as they act as indirect accelerators. Similarly wax and resin based compounds are also suggested.

Pressure Reduction

These days, pressure reducing valves are being very commonly installed in high rise residential and commercial buildings to help to maintain a consistent water pressure at the water fixtures across the entire building from top to bottom. With these higher pressures, water flows through the system with greater flow through the terminal fixtures beyond rated flow capacities, this additional water is wasted and it serves no extra benefit to the rated performance. Most plumbing codes demand pressure reducing valves on the systems where water pressures exceed 80 psi and in most of the cases, pressures can be depressed through the implementation of supplementary pressure-reducing valves. In addition to that, higher pressures could break pipes and damage fixtures which could result in even greater waterwaste in domestic settings.

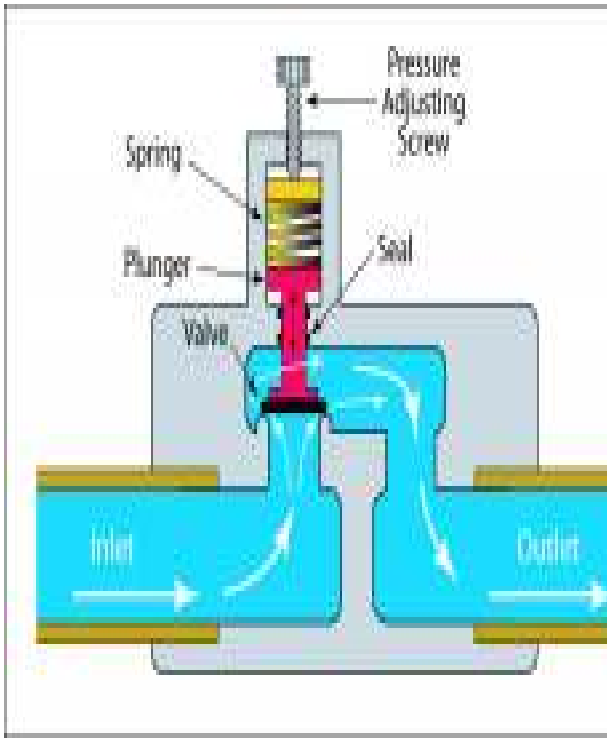


Fig: Pressure reducing valve

Low-Flow Plumbing Fixtures

Low-flow plumbing fixtures like faucets, showerheads, and toilets have become an increasingly common feature in green homes today, and for good reason. Large quantities of water are saved by the use of plumbing fixtures which are designed to operate with less water. For example, toilets were once made to function using 7 gallons per flush, but these days they can efficiently operate using only 1.3 gallons – this clearly means water savings of over 80 percent.

To increase indoor water use efficiency:

- Minimize the distance between the hot water heater and the kitchens and bathrooms. Install point-of-use water heaters or hot water recirculation devices in rooms more than 30 pipe-feet away from the main hot water heater. This saves water by shortening the wait time for hot water and also saves energy, materials, and pipe installation costs.
- Choose an efficient hot water heater and insulate it and all hot water pipes
- Install low-flow showerheads and kitchen and bathroom sink faucet aerators (< 2.5, 2.0, and 1.5 gallons per minute, respectively)
- Install high efficiency toilets (HETs), which use less than the 1.6 gallons per flush of ultra-low flush toilets, or dual flush toilets, which use up to 67% less water than conventional toilets
- Place clothes washers and dryers in a central area instead of in individual units
- Select water-efficient appliances: dishwasher, washing machine
- Use automatic shut-off faucets and composting and/or waterless toilets for common areas.

To increase outdoor water use efficiency:

- Plant drought-resistant varieties and supplement soils to improve water retention
- Install low-volume, non-spray irrigation systems with a preference for drip irrigation. Bubblers, soaker hose, and stream-rotator spray heads are other options
- Separate the irrigation controls for areas with different irrigation needs
- Provide water only as it is needed by using weather-based irrigation controls such as soil moisture sensors or computer-based weather record systems
- Maintain the irrigation system.

To make use of rainwater and greywater:

- Reduce water needs for irrigation by collecting and using rainwater and excess groundwater from sump pumps
- As permitted by local code, reuse greywater from laundry, showers, and sinks to irrigate and to flush toilets
- Rain barrels that connect to drain pipe downspouts are a great way to start.

Rainwater Harvesting in Green Building:

Rainwater harvesting (RWH) is the collection and storage of rain, rather than allowing it to run off. Rainwater is collected from a roof-like surface and redirected to a tank, cistern, deep pit (well, shaft, or borehole), aquifer, or a reservoir with percolation. Dew and fog can also be collected with nets or other tools. Rainwater harvesting differs from stormwater harvesting as the runoff is collected from roofs, rather than creeks, drains, roads, or any other land surfaces. Its uses include watering gardens, livestock, irrigation, domestic use with proper treatment, and domestic heating. The harvested water can also be committed to longer-term storage or groundwater recharge.

Tamil Nadu was the first state to make rainwater harvesting compulsory for every building to avoid groundwater depletion. The project was launched in 2001 and has been implemented in all rural areas of Tamil Nadu. Posters all over Tamil Nadu including rural areas create awareness about harvesting rainwater. It gave excellent results within five years, and slowly every state took it as a role model. Since its implementation, Chennai had a 50% rise in water level in five years and the water quality significantly improved.

Rain water harvesting techniques:

There are two main techniques of rain water harvestings.

- Storage of rainwater on surface for future use.
- Recharge to ground water.

The storage of rain water on surface is a traditional techniques and structures used were underground tanks, ponds, check dams, weirs etc. Recharge to ground water is a new concept of rain water harvesting and the structures generally used are

Pits :- Recharge pits are constructed for recharging the shallow aquifer. These are constructed 1 to 2 m, wide and to 3 m. deep which are back filled with boulders, gravels, coarse sand.

Trenches:- These are constructed when the permeable stram is available at shallow depth. Trench may be 0.5 to 1 m. wide, 1 to 1.5m. deep and 10 to 20 m. long depending up availability of water. These are back filled with filter. materials.

Dug wells:- Existing dug wells may be utilised as recharge structure and water should pass through filter media before putting into dug well.

Hand pumps :- The existing hand pumps may be used for recharging the shallow/deep aquifers, if the availability of water is limited. Water should pass through filter media before diverting it into hand pumps.

Recharge wells :- Recharge wells of 100 to 300 mm. diameter are generally constructed for recharging the deeper aquifers and water is passed through filter media to avoid choking of recharge wells.

Recharge Shafts :- For recharging the shallow aquifer which are located below clayey surface, recharge shafts of 0.5 to 3 m. diameter and 10 to 15 m. deep are constructed and back filled with boulders, gravels & coarse sand.

Lateral shafts with bore wells :- For recharging the upper as well as deeper aquifers lateral shafts of 1.5 to 2 m. wide & 10 to 30 m. long depending upon availability of water with one or two bore wells are constructed. The lateral shafts is back filled with boulders, gravels & coarse sand.

Spreading techniques :- When permeable strata starts from top then this technique is used. Spread the water in streams/Nalas by making check dams, nala bunds, cement plugs, gabion structures or a percolation pond may be constructed.

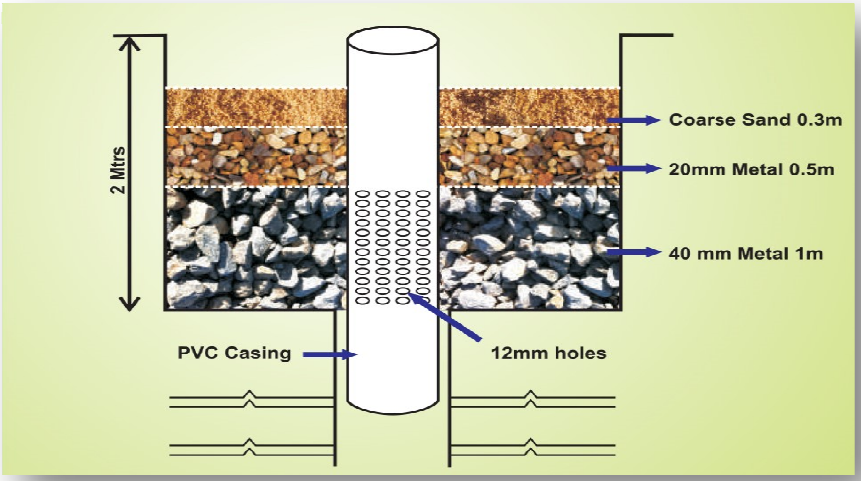
In independent houses and apartments, where there is sufficient open place, we can have recharge pit/ trench with storage sump for rain water harvesting and storage. Excess rain water filling

the sump shall be conveyed to the recharge pit for ground water recharge. Like this, the rain water collected in a 2 cubic mts sump could be sufficient for 5 members of a family for direct use for a period of 4 to 5 days. In places where there is hard rock or clayey soil within 2 mts depth from the ground level, we can have only storage sump of 4 cubic mts. capacity in 100 sq. mts. roof top area and divert rain water through pipes, which could be directly used.

Methods of Rainwater Harvesting

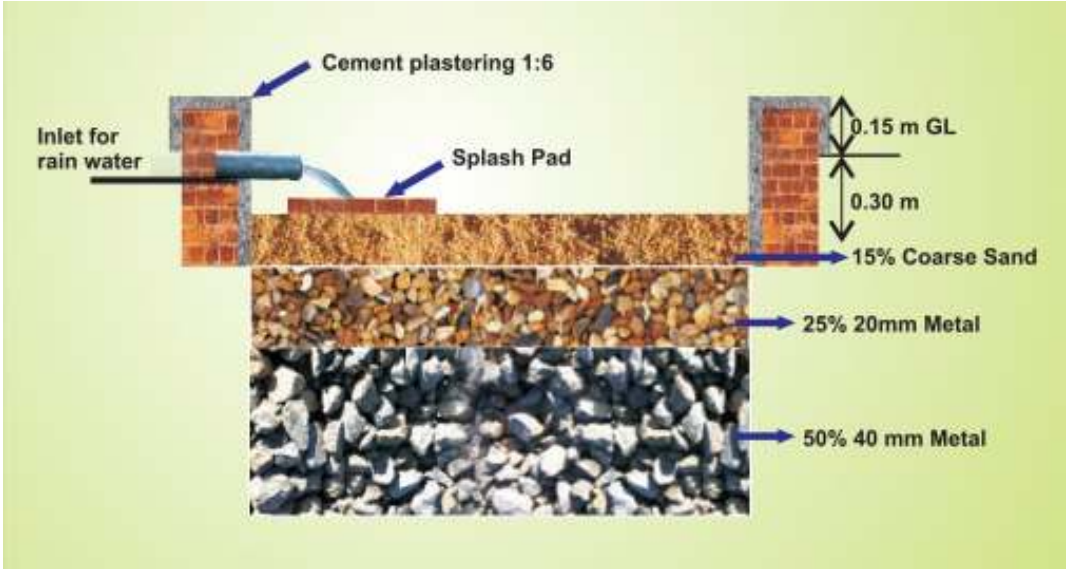
Roof top water collection and recharge:

Commonly runoff water from roof tops are let off into the drains. Instead of this the outlets can be connected through a pipe to storage tank and let into filter media filled trenches, pits or existing open wells, borewells etc.



Design of Pit

The trench/ Pit is to be partially filled with permeable material like well rounded pebbles, gravel and topped with river sand for better percolation.



Design aspects

- Trenches of 0.5 mts. width along the compound wall, to a depth of 2 to 3mts pits of 1 metredia to a depth of 2 to 3mts.
- Suggested volume of trench/ pit is – 6 cubic mts.- for 100 sq. mts.
- Roof top area and the estimated cost Rs. 3010/- per cubic metre

Meter Tables:

Roof top Area in Sq.Mt.	Volume of Harvesting Pit (Cu.Mt.)	Length (Meters)	Breadth (Meters)	Depth (Meters)
100	6.0	2.00	1.5	2.00
200	12.0	3.00	2.00	2.00
300	18.0	4.00	2.25	2.00

Filter Unit Details:

The Residents of school complexes can safely utilize rain water for their domestic requirements by way of filtering it & collecting into sumps and recharging the borewells.

Cost: According to the experts the approximate cost of constructing percolation pits in a house would not be more than 0.5 percent of the total cost of the house.

Maintenance Tips:

1. Rainwater Harvesting Structures

- Structures should be identifiable by display boards and they should be maintained properly by fencing to avoid urination, littering with garbage dumps.
- Periodical removal of top layer, cleaning and replacement.
- Suggested to establish observation wells for monitoring of water levels and quality in influence zone.
- The builders, NGO's and academic institutions should be involved at all stages of programmei.e. to propagate importance of maintenance.

2. Rain Water Storage tanks

- Drain the tank completely and clean the tank from inside thoroughly before the monsoon.
- Clean the work channels (Gutters) often during rainy season and definitely before the first monsoon rain.
- Avoid 15-20 min. of rain fall depending on the intensity of rain. Use the first flush arrangement to drain the first rain water.
- Change the filter media sand every rainy season.
- Cover all inlet and outlet pipes with closely knot nylon net or fine cloth or cap during non-rainy season to avoid entry of insects, worms and mosquitoes

Rainwater harvesting by solar power panels:

Good quality water resource, closer to populated areas, is becoming scarce and costly for the consumers. In addition to solar and wind energy, rainwater is major renewable resource of any land. The vast area is being covered by solar PV panels every year in all parts of the world. Solar panels can also be used for harvesting most of the rainwater falling on them and drinking quality water, free from bacteria and suspended matter, can be generated by simple filtration and disinfection processes as rainwater is very low in salinity**.**

Grey Water Recycling

Grey water can be defined as untreated waste water which has not come into contact with watercloset waste. Basically, it emanates from showers, bathtubs, bathroom wash basins, washingmachines, and dishwashers. Treatment of greywater can include

- Filtering
- Settlement of solids
- Flotation and separation of lighter solids
- Aerobic or anaerobic digestion
- Chemical or UV disinfection

Irrespective of the treatment such water is never safe todrink but can be used for flushing toilets, washing clothes andirrigation purposes. One of the major benefits of recycling greywateris that it is a huge source with a low concentration of organic matter

3.4.4 Conservation & Harvesting Energy

Green buildings often include measures to reduce energy consumption – both the embodied energy required to extract, process, transport and install building materials and operating energy to provide services such as heating and power for equipment. To reduce operating energy use, designers use details that reduce air leakage through the building envelope (the barrier between conditioned and unconditioned space). They also specify high-performance windows and extra insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter. In addition, effective window placement (day lighting) can provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy costs.

Onsite generation of renewable energy through solar power, wind power, hydro power, or biomass can significantly reduce the environmental impact of the building. Power generation is generally the most expensive feature to add to a building.

Passive solar design will dramatically reduce the heating and cooling costs of a building, as will high levels of insulation and energy-efficient windows. Natural daylight design reduces a building's electricity needs, and improves people's health and productivity. Green buildings also incorporate energy-efficient lighting, low energy appliances, and renewable energy technologies such as wind turbines and solar panels.

Passive Solar Designlandscaping:

Passive solar building design and energy-efficient landscaping support the low-energy house in conservation and can integrate it into a neighborhood and environment. Following passive solar building techniques, where buildings are compact in shape to reduce surface area and principal windows oriented towards the equator (south in the Northern Hemisphere and north in the Southern Hemisphere) maximizes passive solar gain. However, solar gain (especially in temperate climates) is secondary to minimizing the overall house-energy requirements. In hot temperatures, excess heat can create uncomfortable indoor conditions. Passive alternatives to air-conditioning systems, such as temperature-dependent venting, have been shown to be effective in regions with cooling needs. Other techniques to reduce excess solar heat include brise-soleils, trees, attached pergolas with vines, vertical gardens, and green roofs.

Although low-energy buildings can be constructed from dense or lightweight materials, internal thermal mass is normally incorporated to reduce summer peak temperatures, maintain stable winter temperatures, and prevent possible overheating in spring or autumn before the higher sun angle "shades" midday wall exposure and window penetration. Exterior wall color (when the surface allows choice) reflection or absorption depends on the predominant year-round outdoor temperature. The use of deciduous trees and wall trellised (or self-attaching) vines can assist in temperate climates.

Passive solar design uses sunshine to heat, cool and light homes and other buildings without mechanical or electrical devices. It is usually part of the design of the building itself, using certain materials and placement of windows or skylights.

- **Rules of Passive Solar Systems:**

- The building should be elongated on an east-west axis.
- The building's south face should receive sunlight between the hours of 9:00 A.M. and 3:00 P.M. (sun time) during the heating season.
- Interior spaces requiring the most light and heating and cooling should be along the south face of the building. Less used spaces should be located on the north.

- **The Advantages of Passive Solar Design:**

- High energy performance: lower energy bills all year round.
- Investment: independent from future rises in fuel costs, continues to save money long after initial cost recovery
- Value: high owner satisfaction, high resale value
- Attractive living environment: large windows and views, sunny interiors, open oor plans
- Low Maintenance: durable, reduced operation and repair
- Unwavering comfort: quiet (no operating noise), warmer in winter, cooler in summer (even during a power failure)
- Environmentally friendly : clean, renewable energy doesn't contribute to global warming, acid rain or air pollution

Passive Solar Heating:

The goal of all passive solar heating systems is to capture the sun's heat within the building's elements and release that heat during periods when the sun is not shining. At the same time that the building's elements (or materials) is absorbing heat for later use, solar heat is available for keeping the space comfortable (not overheated).

- **Two primary elements of passive solar heating are required**

- South facing glass
- Thermal mass to absorb, store, and distribute heat

- **Approaches to passive systems**

- Direct Gain: Sunlight shines into and warms the living space
- Indirect Gain: Sunlight warms thermal storage, which then warms the living space
- Isolated Gain: Sunlight warms another room (sunroom) and convection brings the warmed air into the living space

Lighting and electrical appliances

To minimize total primary energy consumption, passive and active day lighting are the first daytime solutions to employ. For low-light days, non-daylight spaces and nighttime, sustainable lighting design with low-energy sources (such as standard-voltage compact fluorescent

lamps and solid-state lighting with LED lamps, OLEDs and polymer light-emitting diodes and low-voltage incandescent light bulbs, compact metal halide, xenon and halogen lamps) can be used.

Solar-powered exterior security and landscape lighting, with solar cells on each fixture or connecting to a central solar panel, are available for gardens and outdoor needs. Low-voltage systems can be used for more controlled (or independent) illumination, using less electricity than conventional fixtures and lamps. Timers, motion detection and day lighting operation sensors further reduce energy consumption and light pollution.

Cooling Towers

Green buildings make use of evaporative cooling systems to save onenergy. Such systems use water for cooling. Keeping in mind thehuge need to conserve water, the water used such cooling towers is non-potable water and the same is not drained out but recycled timeand again and reused.

High performance Glass

High Performance Glass is one which reduces the ingress of heat and at the same time allows higher penetration of daylight.

Glass has been used for hundreds of years in architecture. Glass forms a major part of the outer envelope of buildings. It is also used to form internal building features such as partitions, doors and enclosures.

Of late, glazing is a favoured feature in buildings. Glazing not only adds to the aesthetic element but also has a tremendous impact on energy performance of buildings besides visual and acoustic effects. The right choice of glazing can also lead to significantly lower cost in building.

With an increasing need for resource efficient building solutions, selection of glazing assumes tremendous significance. Construction industry in India is poised for a rapid growth and hence the per capita consumption of glass is expected to grow rapidly from the existing 0.54 kg per capita.

Benefits of Using High Performance Glass:

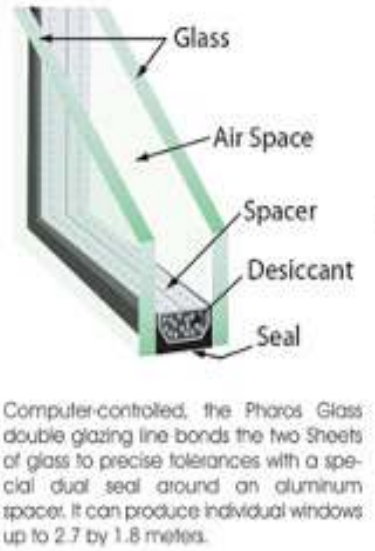
- It can result in energy saving to the tune of 35-40% as compared to conventional glass
- Typical payback period varies from3-4 years
- It Provides access to day lighting which can enhance occupant comfort and productivity

Types of Glazing or Glass

There are many types of glazing available which include the following:

(i) Insulated glazing (double-glazed, triple-glazed):

Insulated glazing refers to glazing units consisting of two or more panes of glass. Insulated glazing can be double-glazed or triple- glazed. The glass panes are spaced apart and sealed to form a single-glazed unit with an air space between each pane of glass. The glass layers and the air spaces resist heat flow.



Computer-controlled, the Pharos Glass double glazing line bonds the two sheets of glass to precise tolerances with a special dual seal around an aluminum spacer. It can produce individual windows up to 2.7 by 1.8 meters.

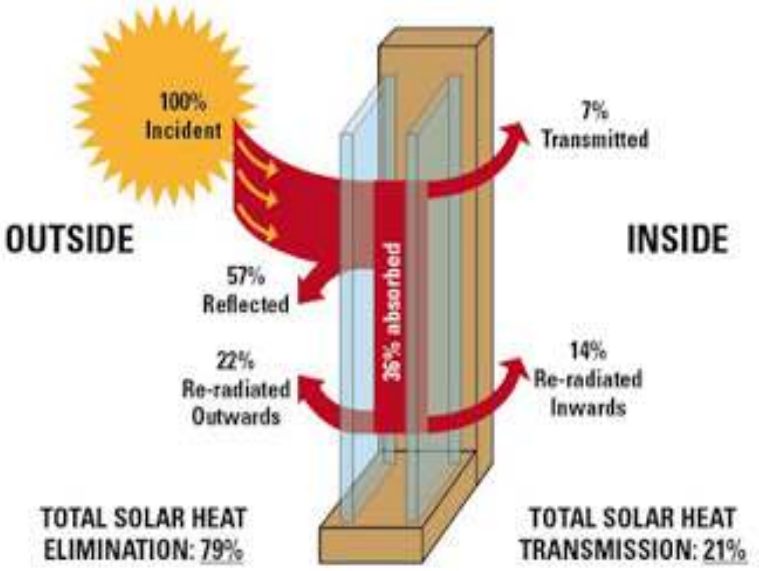


Fig: Insulated glazing (double- glazed, triple-glazed)

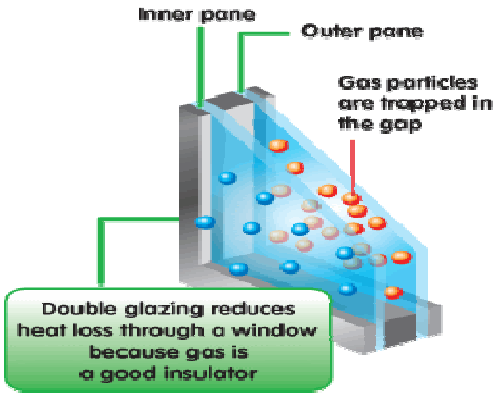


Fig: Gas filled glazing

(ii)Gas filled glazing:

To improve the thermal performance of glazing, the space between the glass panes is filled with inert gas. Because these gases have a higher resistance to heat flow than air, they are sealed between the window panes . The most common types of gas used include argon and krypton.

(iii)Heat-absorbing tints:

Tinted glass absorbs a large fraction of the incoming solar radiation and glare thus reducing the solar heat gain coefficient. However they also reduce visible light transmittance. Gray- and bronze-tinted glazings reduce the penetration of both light and heat. Blue- and green-tinted windows offer greater penetration of visible light and slightly reduced heat transfer compared with other colors of tinted glass. Tinted glass reflects only a small percentage of light, so it does not have the mirror-like appearance of glass reflective coating.

Fig: blue tinted glass

Fig: Low-E coating glass

(iv) Low-emissivity (Low-E) coatings:

Low Emissivity (Low-E) coatings are microscopically thin, virtually invisible, metal or metallic oxide layers deposited on a window or skylight glazing surface primarily to reduce the U-factor by suppressing radiative heat flow. In general, low-E coatings are designed to reduce heat transfer caused by long wave radiation.

Clear glass has an emissivity of 0.84 which means that it absorbs 84% of long wave radiation and reflects 16%. Low-E coatings typically have emissivity ranging from 0.35 to as low as 0.04 , which means 65% - 96% of the long wave radiation is reflected back to the atmosphere.

(v) Spectrally selective glass:

Spectrally selective glass also blocks long wave radiation, but they have another important function. The multiple layers of silver in the coating allow the glass to selectively transmit and reject certain wavelengths of solar radiation. Spectrally selective glass is very similar to Low-E glass in the sense that it restricts heat ingress but the difference lies in its capacity to transmit visible light.

(Vi) Reflective coatings:

Reflective coatings usually consist of thin, metallic layers which come in a variety of colors including silver, gold, and bronze. Reflective coatings are applied on the outer surface of glazingsi.e. the surface exposed to rain. Reflective coatings on window glazing or glass reduce the transmission of solar radiation, thereby blocking heat. However they also reduce a window's visible light transmittance (VLT). Reflective window glazing is commonly used in hot climates where solar heat gain control is critical. Reflective glazing is used by many architects because of its glare control and uniform exterior appearance.

Insulation Techniques:

Popular materials used for insulation are fiber glass, rock wool, and slag wool. After being manufactured these items require no energy to use and require no maintenance unless damaged. Using inflation properly is the most effective way to reduce energy use and greenhouse gas emissions.

- Using insulation reduces average home heating and cooling costs by around 20%.
- For every pound of carbon dioxide emitted in the production of insulation, 330 pounds of carbon dioxide are avoided by the use of insulation.

- Fiber glass and rock and slag wool products are reusable. They can be easily removed and put back into place.
- According to the Department of Energy, heating and cooling systems use more than half of the energy consumed in American homes. Typically, 42% of the average family's utility bill goes to keeping homes at a comfortable temperature. The energy sources that power these heating and cooling systems emit more than 500 million tons of carbon dioxide and 12% of the nitrogen oxide emissions, the active components in acid rain. By combining proper equipment maintenance, upgrades, insulation, weatherization, and thermostat management, you can reduce your energy bills and emissions by half.

Autoclaved Aerated Concrete Blocks

Autoclaved Aerated Concrete (AAC) blocks are produced using materials including silica sand, lime, cement, gypsum, water, fly-ash and aluminum powder. The special combination of these substances yields a material with excellent construction properties such as thermal insulation, structural strength, density and fire resistance.

Extruded Polystyrene

Extruded polystyrene (XPS) is a type of insulation material with a high R-value, good moisture resistance, high structural strength and low weight. Extruded polystyrene is used extensively as thermal insulation in industrial, commercial and residential construction. It is commonly used in wall and roof applications.

Expanded polystyrene

Expanded polystyrene (EPS) is a type of insulation that provides thermal and acoustical insulation with characteristics such as low weight, high moisture resistance and high structural strength. Expanded polystyrene can be used to insulate the walls and roofs. Commercially this is often referred to as thermocol.

Glass wool

Glass wool is an insulation material which gives efficient thermal insulation. It is light in weight and provides good acoustic insulation also. It is commonly used for duct and wall thermal insulation.

Fig: Rat trap bond filled with glass wool

Plant-based Polyurethane Rigid Foam

There is a new "generation" of insulation being released to the public recently. Plant-based Polyurethane Rigid Foam is made from plants such as bamboo, hemp, and kelp, that "offers high moisture and heat resistance, excellent acoustics and protection against mold and pests. It also has a higher R-value than fiberglass or polystyrene, meaning that it has a higher thermal resistance and insulates better. The hygroscopic properties of bio-based insulation mean that they can absorb and store moisture from the surrounding air. The material behaves as a moisture buffer. This softens the relative humidity changes in the environment, reducing risks from common pollutants such as bacteria, viruses, chemical reactions, allergies and respiratory infections, as well as reducing the need for air-conditioning. These plant-based insulation techniques can be cheaper, healthier, save more energy in houses and buildings, as well as cut energy consumption in the manufacturing process of insulation.

Cool Roofing

Another more efficient way to cut energy consumption and save money along with newer plant-based insulation is with proper roofing. "Cool Roofing" involves using roofing which direct sunlight back into the atmosphere instead of being absorbed by the material and being passed into the building. This Cool Roofing can save money by lowering the cost of keeping a building cool with air conditioners. The same process can be used to keep heat in and lower the cost of a heating bill. A cool roof is one that has been designed to reflect more sunlight and absorb less heat than a standard roof. Cool roofs can be made of a highly reflective type of paint, a sheet covering, or highly reflective tiles or shingles.

Benefits of a Cool Roof:

- Reducing energy bills by decreasing air conditioning needs.
- Improving indoor comfort for spaces that are not air conditioned.
- Decreasing roof temperature, which may extend roof service life.
- Reduce local air temperatures (sometimes referred to as the urban heat island effect).
- Lower peak electricity demand, which can help prevent power outages.
- Reduce power plant emissions, including carbon dioxide, sulfur dioxide, nitrous oxides, and mercury, by reducing cooling energy use in buildings.

Insulation applications

Heat balance of a building would reveal that at least 15 to 20 % of the heat ingress into a building can be through walls and roof. Hence, insulating walls and roof is extremely critical in the energy performance of a building.

The insulation applications are given below

1.Wall insulation

Walls can be insulated on exterior or interior depending on the architectural aesthetics required. Typical way of insulating an exterior wall is shown in figure

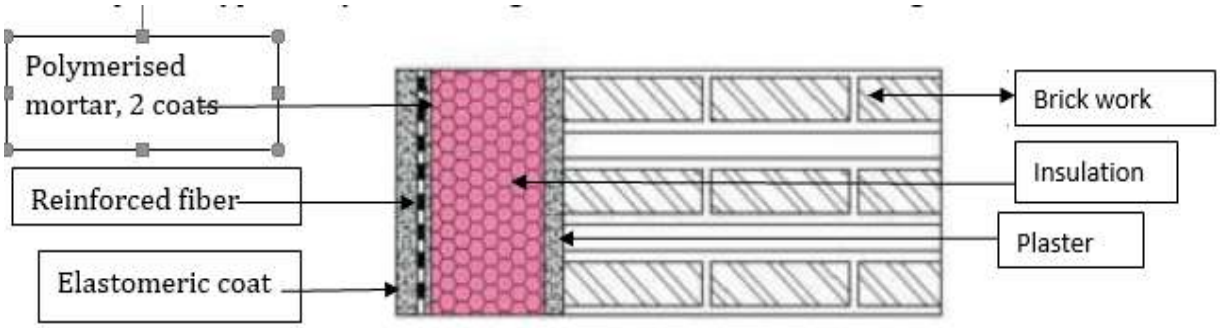


Fig: Exterior wall Insulation

In many of the buildings, insulation can be done on interior also.

Air cavity walls

Air can also be an excellent insulator. Many of the buildings have been constructed with the masonry brick walls with an air gap of 20 to 30 mm, which provides good insulation

Roof insulation

Roof can be insulated either over the deck or under the deck. Generally, over deck insulation is preferred, so as to avoid the absorption and retention of heat by the concrete surface. Under deck insulation can also be considered but the thickness of insulation should be higher

3.4.5 Eco-Friendly Construction Materials

We are traditionally used to using earth bricks, concrete, and wood in construction. They have been, and continue to be used in everyday construction, meaning the continued destruction of trees for timber, and the mining of resources to produce cement for binding sand, gravel, and bricks. For a better world, there are new processes, and sustainable as well as green building material alternatives that can be used in construction today.

Building materials typically considered to be 'green' include lumber from forests that have been certified to a third-party forest standard, rapidly renewable plant materials like bamboo and straw, dimension stone, recycled stone, recycled metal and other products that are non-toxic, reusable, renewable, and/or recyclable. For concrete a high performance or Roman self-healing concrete is available.

Sustainable and Green Building Materials That Can Be Used in Construction

(i)Bamboo

Bamboo is considered one of the best eco-friendly building materials. It has an incredibly high self-generation rate, with some being reported to have grown up to three feet within 24 hours. It continues spreading and growing without having to be replanted after harvest. Bamboo is a perennial grass and not wood and grows on every continent, except Europe and Antarctica.

It also has a high strength-to-weight ratio, even greater comprehensive strength than concrete and brick, and lasts incredibly long. It is, therefore, the best choice for flooring and cabinetry. Unfortunately, bamboo requires treatment to resist insects and rot. If left untreated, bamboo contains a starch that greatly invites insects, and it could swell and crack after absorbing water.

(ii) Cork

Just like bamboo, cork grows very quickly. It can also be harvested from a living tree, which continues to grow and reproduce more cork, which is a tree bark. Cork is resilient, flexible and reverts to its original shape even after enduring sustaining pressure. Its resilience and resistance to wear, makes it a common element in floor tiles.

It also excellently absorbs noise, making it perfect for insulation sheets, and due to its excellent shock absorption qualities, it perfect for sub-flooring. It can also be a good thermal insulator as it is fire resistant, especially if untreated, and does not release toxic gases when it burns. Cork, in being nearly impermeable, does not absorb water or rot.

(iii)Straw Bales

It is another green building material that can be used as a framing material. They havegood insulation properties and can act as soundproof material. It can also be used as fill material in between columns and in beams framework/ as they cannot allow air through, they can have some fire resistance properties.

Straw can be harvested and re-planted easily with minimal environmental impacts. Making straw into bales also has very low influence. They can also be placed in walls, attics and ceilings, to contribute to cooler the house in the summer and warmer temperatures in the winter.

(iv) Recycled Plastic

Rather than sourcing, mining and milling new components for construction, manufacturers are using recycled plastic and other ground-up trash to produce concrete. The practice is reducinggreenhouse gas emissions and is giving plastic waste new use, rather than clogging landfills and contributing to plastic pollution.

A blend of recycled and virgin plastic is also used to make polymeric timbers, for use in making fences, picnic tables and other structures, at the same time, saving trees. Plastic from two-liter bottles can be spun into fiber for the production of carpets. Reused plastic can also design products such as cable pipes, roofs, floors, PVC manholes, and PVC windows.

(v) Reclaimed wood

Using reclaimed wood is one of the most environmentally responsible ways to save trees and reduce the amount of lumber in landfills. Reclaimed wood can be found in retired barns, excavation companies, home remodeling contractors and companies, salvage yards, and shipping crates and pallets.

Reclaimed wood is good for structural framing, cabinetry, and flooring. It is lightweight but has less strength and each piece's integrity should be assessed and chosen for an appropriate project. Also, most wood is susceptible to insects and degradation, meaning it needs reinforcement and additional treatment.

(vi) Reclaimed or recycled steel

Steel can be used for the framing process, in place of wood, increasing the durability of a structure against earthquakes and high winds. A 2,000-square foot house requires about 50 trees to build, but a frame made from recycled steel requires the steel equivalent of just six scrapped cars.

Steel is 100% recyclable and significantly reduces the ecological impact of new construction. Mining, heating and shaping products made from aluminum and steel requires a lot of energy, but properly and efficiently reusing or recycling them into new products, lowers the energy used, and makes the material more sustainable, the recycled metal is long-lasting and does not require frequent replacements.

It does not burn or wrap and is therefore perfect for roofing, building facades and structural support. Additionally, recycled steel is water- and pest-resistant.

(vii) Plant based Polyurethane rigid foam

Rigid foam has for long been used as insulation material in building. It was first used after a top manufacturer of surfboard material, was fined by the EPA, and subsequently put out of business, for using a toxic material. The new surfboard material was made from plant-based polyurethane rigid foam, which came from bamboo, kelp and hemp, rejuvenating the surfboard industry.

It is now in use in the manufacturing process including that of turbine blades and furniture. The material is rigid and relatively immovable, meaning it can be used for insulation. Additionally, it offers protection against mould and pests. It is also heat resistant, protects against mould and pests, and can be perfect as sound insulation.

(viii) Rammed Earth

It is a technology that has been used throughout human civilization for thousands of years and lasts a very long time. It is a popular and affordable solution to creating steadfast foundations, floors and walls, through natural materials such as chalk, earth, gravel or lime, and then compacting them.When pressed tightly in wooden forms, it creates walls that have a similar feel to concrete. Buildings made from rammed earth are made safer or fortified by the use of rebar or bamboo. Mechanical tamper can greatly reduce the amount of labor required to create sturdy walls. Rammed earth walls and floors can be used as thermal storage, allowing the sun to warm them in the day and slowly release the warmth in the cooler evenings.

(ix) Hempcrete

It is a concrete-like material created from the woody inner fibres of the hemp plant. The fibres are bound with lime to create concrete-like shapes that are strong and light. Hemp concrete blocks are lightweight, dramatically reducing the energy used to transport the blocks. Hempcrete is sturdy, has good thermal and acoustic insulation qualities and is fire resistant. Additionally, its biggest sustainable property is that it is CO_2 negative, meaning it absorbs more CO_2 than it emits. Hemp itself is a fast-growing and renewable resource.

(x) Ferrock

It is a relatively new material and it uses recycled materials such as steel dust from the steel industry, or ferrous rock leftover from industrial processes, usually sent to the landfill. It creates a concrete-like building material, stronger than the concrete itself. It traps and absorbs carbon dioxide as part of its drying and hardening process. This makes ferrock carbon neutral and a lot less CO_2 intensive as compared to traditional concrete. It is a viable alternative to cement and can be mixed and poured to form driveways, staircases, pathways, and more structures. Some researchers believe ferrock is more resilient to weather than concrete.

(xi) Timbercrete

This is an interesting building material and is made from a mix of sawdust and concrete. It is lighter than concrete and reduces transportation emissions. The sawdust also reuses a waste product and replaces some of the energy-intensive components of traditional concrete. Timber concrete could also be formed into traditional shapes like pavers, bricks and blocks.

(xii) Terrazzo

This is a mosaic style of flooring where small pieces of marble or granite are set in polished concrete or epoxy resin. When well maintained, terrazzo floors can last up to 40 years without losing their brilliance. The original terrazzo was set in cement.

Today, 90% of terrazzo floors are made with an epoxy resin. A company like Terrazzo & Marble Supply company manufactures 'forever floors' from their own epoxy, which incorporates materials like brass, aluminum and zinc, along with recycled glass, beer bottles, marbles and porcelain.

A terrazzo floor might be more expensive than carpets, but you will have to replace carpets. Terrazzo floor, on the other hand, can last for over four decades, making it a sustainable building material. Additionally, before pouring terrazzo into place, you can use the color of your choice and make the floor of your choosing. It makes for easy-to-clean floors, which can also be installed in high-traffic areas like schools, airports, and stadiums.

Steps for Material Selection

Material selection can begin after the establishment of project-specific environmental goals. The environmental assessment process for building material involves three basic steps.

1. Survey
2. Evaluation
3. Selection

1. Survey:

This step involves gathering of all technical information about the material which can be identified, including manufacturers' information such as Material Safety Data Sheets (MSDS), Indoor Air Quality (IAQ) test data, product warranties, source material characteristics, recyclable content data, environmental, performance and durability information. In addition, this step may also involve investigating other issues like building codes, government regulations, building industry performance, model green building product specifications etc. Such survey will help in identifying the full range of the project's material, options.

2. Evaluation:

This step involves confirmation of the technical information, as well as filling in information gaps. For example, the evaluator may request product certifications from manufacturers to help sort

out possible exaggerated environmental product claims. Evaluation and assessment is relatively simple when comparing similar types of building materials using the environmental criteria. However, the evaluation process is more complex when comparing different products with the same function. Then it may become necessary to process both descriptiveand quantitative forms of data.A life cycle assessment (LCA) is an evaluation of the relative "greenness" of building materials and products. LCA addresses the impact of a product through all of its life stages. This tool that can be used is the LCA methodology through a software evaluation like BEES (Building for Environmental and Economic Sustainability) software. Such software can easily be developed or otherwise available commercially. It allows users to balance the environmental and economic performance of building products.

3. Selection:

This step often involves the use of an evaluation matrix for scoring the project-specific environmental criteria. The total score of each product evaluation will indicate the product with the highest environmental attributes. Individual criteria included in the rating system can be weighted to accommodate project-specific goals and objectives.

3.4.6 Indoor Environment Quality (IEQ)

The effect of indoor environmental quality (IEQ) in buildings on occupants' health, well-being, and productivity is an important topic in occupational health and public health. Buildings which are facilitated by green features provide clean and more comfortable environment for their occupants. .IEQ can influence occupant's health condition positively or negatively. IEQ can negatively affect occupants' physical health (e.g., asthma exacerbation and respiratory allergies) through low air quality, high or low temperatures, excess humidity, and insufficient ventilation and psychological health (e.g., depression and stress) through inadequate lighting, acoustics, and ergonomic design. Therefore to have a healthy life, we need to more concentrate on buildings impacts on their occupants. It is an important issue for both residential and commercial buildings. The green building development is attempting to address IEQ and occupants' health concerns by providing greener, cleaner and healthier build environments.

Indoor air quality

Indoor air quality is affected by volatile organic compounds (VOC's) emitted by most interior products. The extent of this impact depends on the combined emissions from products such as paint, cleaning materials, building materials, furnishings, fabrics, etc. Apart from products, activities such as tobacco use, pets, and inadequate ventilation also add to poor indoor air quality.

Green paints for Green Buildings

Paints can have a major impact on the overall aesthetics of a space; sometimes more than even flooring and furnishings because of the enormous square footage of coverage Paints may also have a major negative impact on the indoor air quality of a building, because they may contain

chemicals called Volatile Organic Compounds (VOCs) and other toxic components that evaporate into the air and are harmful to the health of the occupants. VOC are a primary contributors to smog generation.

Environmental effects paints:

Paint has three major components: a pigment for color, a binder that holds the pigment to the surface and a carrier or solvent (mineral spirits or water) to dissolve and maintain the pigments. Latex, water-based paints have significantly lower environmental impacts than oil or solvent-based paints since they don't use petroleum carriers or have nearly as many smog-forming emissions. According to the US Environmental Protection Agency(U5 PA), 9% of the airborne pollutants creating ground level ozone come from the VOCs in paint. LOW and zero VOC paints have little or no smog-forming emissions.

Benefits of Low VOC Paints:

Environmental

VOCs react with sunlight and nitrogen oxides in the atmosphere to form ground-level ozone, a chemical that has a detrimental effect on human health, agricultural crops, forest and ecosystems. These problems can be eliminated using low VOC paints

Economic:

Healthy occupants are more productive and have less illness-related absenteeism. Use of high-VOC content materials can cause illness and may decrease occupant productivity, These problems result in increased expenses and liability for building owners, operators and insurance companies.

Indoor Environment:

Selecting materials that are low in VOC helps reduce sources of pollutants during the construction process and in the finished building. Also low VOC paints have little odor.

Potential Health Effects of Paints

Paint is applied wet and must undergo a drying process, and sometimes a chemical reaction, in order to form a solid paint film on the wail or other surface. It is during this drying or chemical process that VOCs and other paint components are released. Many paints contain a high percentage of VOCs so that they will dry faster. Paints also continue to off gas somewhat for many days, weeks, and months after application and especially each time the temperature and humidity in the room rises.

VOC refers to a class of chemicals which evaporate readily at room temperature. They are in all oil-based paints as solvents. Many latex paints (which use water as the "solvent'' or carrier) also

contain VOCs as part of their paint chemistry. When these VOCs off-gas, they may cause a variety of health problems like nausea, dizziness, irritation of the eyes & respiratory tract, and more serious illnesses like heart, lung or kidney damage and cancer,

Certain people are particularly susceptible to these effects, including those with weakened immune systems or chemical sensitivities, asthmatics, young children and the elderly. In the case of these sensitive occupants, be sure products are tested for VOCs before applying. Since low- or no-VOC paints

- Sometimes simply washing walls and/or using a little touch - up paint can make them appear new. When it is necessary to paint, use least toxic and/or Low- or No-VOC products, and water-based paints. This will also eliminate the need for toxic solvents for cleanup.
- Remember that a more durable paint is less expensive in the long run. A 10-year paint may cost a little more than a 5-year, but there is only a one-time labor cost, which is the most expensive part of most paint jobs.
- Proper preparation is also critical for a durable paint application. All surfaces must be clean and dust free, with any visible cracking, peeling or blistering removed.
- If there is existing paint, determine what it is and appropriately prepare for the next coat. Be sure to choose primers and top coats that are compatible.

Green Paints	**Conventional Paints**
Cleaner air: reduced ozone depletion	contribute to environmental pollution and ozone depletion
Minimal health risks	Significant health risks
Total Cost: same as any High quality paint &low o & m costs	Low but with high o & m costs

CHAPTER-4 ALTERNATE CONSTRUCTION TECHNOLOGIES IN CONSTRUCTION OF SCHOOL BUILDINGS

4.1 Introduction

Present Construction Technology adopted in TW Institution Infrastructure

When the TW Engineering Dept is formed in 1984, the infrastructure requirements for Educational and Health Institutions were taken up with Govt of India Schemes like NREP, RLEGP, Drought, Food for Work etc. The scheme objectives such as providing wage employment to the labourers was kept in mind in designing of a suitable construction methods such as Load bearing Structures using locally available Rough Stone for panel walls and bearing walls. Further, in those days, site for construction of a TW

Institution was not an important issue as against what is being observed now. Almost all the buildings were construction as Ground Floor structures alone. When the state Government had started giving importance to Tribal Welfare even though external funding is rarely seen, required sites for new and additional accommodations are necessitated. In the continuous growing trend of taking students every year in the TW Educational Institutions, the situation of demolishing the old structures unless they completed their shelf life, did not araised and hence, within the available balance sites in each Educational Institute premises, construction with framed structures came into practice. This new system is extended even today for starting new structures or for additional accommodations. At present the Cost of construction for a G+2 floored framed structures are around Rs 1800/- excluding taxes and increasing every year due to increase in cost of raw materials such as sand, Cement, Steel, Sanitary and Water supply and Electrical items.

When the framed structures of typical approved designs are being followed, the 2nd obstacle of completion of work in time has been encountered in the department. Even though the construction schedules are prepared duly considering the required physical completion duration, the factors like irregular payments to the contractors, non-availability of skilled construction labour in the remote locations did not helped the department to achieve timely completion of works.

On the other side, construction technologies in India are getting updated on par with the practices and technologies being followed by the developed countries in the world. Further, there is a huge growth in the number of Construction Executing companies which are equipped with latest skilled personnel, machinery and technology.

Hence, based on the availability of latest new technology adaptations in construction technologies, it is observed by the TW Department to provide required exposure and training for its engineering wing field functionaries with a major objective of completing the construction of buildings within an acceptable time limits.

Curved Roofs

These are just the modifications of pitched roofs and are frequently employed in modern age to cover large areas. Shell roofs and domes are the varieties of curved roofs. They are useful for big structures such as factories, monumental works, etc. Curved roofs may be constructed of timber or R.C.C. There are two common-forms of a shell roof.

i. A north light shell roof
ii. A barrel vault shell roof

A dome is a rounded vault forming a roof. It is useful when roof is to be provided on circular brick work or regular polygon shaped walls. Curved roofs afford pleasing appearance and, in most cases, the construction of curved roofs results in the economy of steel and concrete. Due to arch action, the stresses are considerably reduced which result in thin section for the curved roofs. Also, they provide space in the roof which can be utilized for some purpose.

A recent development, known as doubly curved tile roof has combined the advantages of flat roofs and curved roofs. Following is the procedure of making such a roof.

Pre-cost units of cement concrete tiles are prepared at site. The size of tile is kept at about 70cm x 70cm with uniform thickness of at least 20mm. the tiles are in the form of domes with a size of about 50mm. Cement concrete of proportion 1:2:4 is adopted and the units are properly curved.

Pre-cost units of R.C.C beams are prepared and reinforcement is provided as pre design. The dimensions of beams are usually 90mm deep and 130mm wide. The stirrups are kept projecting about 50mm above the precast portion so as to have bond with cast in-site-concrete. Cement concrete of proportion 1:2:4 is adopted and the units are properly curved.The beams are suitably laid across the supporting walls.The tiles are placed in position after spreading some mortar on the edges of beams. The minimum bearing of this on beams should be 25mm and that on walls should be 50mm to 70mm.The haunches between the humps of tiles are filled up with cement concrete of proportion 1:2:4.Suitable water – proofing treatment to the roof is given at the top. The roof thus exhibits a flat surface at the top and curved surfaces at the bottom

The Advantages of doubly curved tile roof are

- It can be constructed in short time as it affords advantages of prefabrication.
- It does not require constant skilled supervision and can easily be adopted for villages.
- It is cheap in construction.
- It requires less frame work.

4.2 Precast concrete

Precast concrete is a construction product produced by casting concrete in a reusable mold or "form" which is then cured in a controlled environment, transported to the construction site and lifted into place ("tilt up"). In contrast, standard concrete is poured into site-specific forms and cured on site.

4.2.1Different types of precast concrete products

Different types of precast products have varied applications. Depending on the shape, size, and grade of concrete used, its function varies. These products are being used in many construction projects wherein uniformity and control are required. Using a precast concrete system offers many potential advantages over onsite casting. Precast concrete production can be performed on the ground level, which helps with safety throughout a project.

Given below are different types of precast concrete products available.

(a) Foundations

Isolated footings –

Isolated footings are commonly used for shallow foundations to carry and spread concentrated loads, caused for example by columns or pillars. Isolated footings can consist either of reinforced or non-reinforced material. These are used for smaller structures and residential buildings.

Fig: Isolated footings

Pocket footings – Pocket footings offer more strength to shallow foundations to carry and spread concentrated loads. They are used for commercial and industrial buildings.

Combined footings – These concrete footings are usually rectangular and support two or more columns that are so close to each other their footings would overlap. They are used for commercial and industrial buildings.

Fig: Pocket footings

Fig: Combined footings

Precast piles – Precast piles are prefabricated piles made of prestressed concrete that are driven into the ground using diesel or hydraulic hammer. The piles are made of prestressed concrete and have fixed dimensions. These piles are used for the most conventional foundation method. It's usually the quickest and also the cheapest method besides the use of wooden piles. The main benefit of these concrete piles is the high vertical pile load and resistance.

Fig: Precast piles

(b) Structural beams

RCC beams – RCC beams are structural elements designed to carry transverse external loads that cause bending moment, shear forces, and in some cases torsion across their length.RCC beams generally have concrete resisting on the compression region and steel resisting applied loads on the tension region. It can be classified as per size into- rectangular, T-Beam, I-Beam, Circular Beam and L-Beam. It is used to support the building's floors, roof, walls and cladding.

Fig: RCC beams

Prestressed beams – FRP-prestressed beams are greater than those of steel-prestressed beams. It is very easy to install with reduced on-site labor needs and costs. It comes in a wide range of depths to meet exact building needs It provides much-needed reinforcement for multi-story buildings and industrial applications.

Fig: Prestressed beams

Shell beams – Shell beams are commonly used with precast floor systems to streamline building programs and reduce on-site labour. Pre-stressed shell beam units, with the addition of a reinforcing cage and on-site concrete. Band depths of 290mm to 600mm and widths of 600mm up to 2400mm are possible. Reinforced Ultrashell beams can span up to 11m, with greater spans possible via the addition of Post Tensioning cables.

Fig:Shell beams

(c) Slabs

RCC slabs – This type of slabs are used for support conditions in buildings.RCC Slabs whose thickness ranges from 10 to 50 centimeters are most often used for the construction of floors and ceilings. Thin RCC slabs are also used for exterior paving purposes. In many domestic and industrial buildings, a thick concrete slab, supported on foundations or directly on the subsoil, is used to construct the ground floor of a building. In high rises buildings and skyscrapers, thinner, precast concrete slabs are slung between the steel frames to form the floors and ceilings on each level.

Fig: RCC slabs

Prestressed hollow core slabs- A hollow core slab, also known as a voided slab, hollow core plank, or simply a concrete plank is a precast slab of prestressed concrete typically used in the construction of floors in multi-story apartment buildings. The production of these elements is achieved using our Extruder and Slipformer machines that cast in one phase along a production bed without the need for any formworks. Hollow core slabs are highly developed structural elements and are used all over the world due to their many advantages and diverse applications.

Fig: Prestressed hollow core slabs

Prestressed solid slabs – The solid slab is a customized, loosely reinforced, full concrete slab that is used in residential and industrial construction. Mounting parts, such as electrical outlets, wiring, openings, etc. or even heating conduits can be previously installed in the solid slab in the precasting plant.

Fig: Prestressed solid slabs

Double tee slabs – A double tee or double-T beam is a load-bearing structure that resembles two T-beams connected side by side. The strong bond of the flange (horizontal section) and the two webs (vertical members, also known as stems) creates a structure that is capable of withstanding high loads whilehaving a long span. It can be applied in roofing, parking and bridges.

Waffle slabs – A waffle slab or two-way joist slab is a concrete slab made of reinforced concrete with concrete ribs running in two directions on its underside. The name waffle comes from the grid pattern created by the reinforcing ribs. Waffle slabs are preferred for spans greater than 40 feet (12 m), as they are much stronger than flat slabs, flat slabs with drop panels, two-way slabs, one-way slabs, and one-way joist slabs. Waffle slab can be used as both ceiling and floor slab. They are used in the areas where less number of columns are provided, i.e. it is used in the areas which have huge spans

Fig:Waffle slabs

(d) Walls

Load bearing external walls – This wall is constructed to support the above slab or other building elements in a structure. These walls are generally 125 mm to 200 mm thick. The thickness depends on the load pattern.

Fig: Load bearing external walls

Non-load-bearing walls – This wall holds up only itself. They carry only their weight and may be any one of the types discussed under load-bearing walls. This type of wall is used to close in a steel or concrete frame building. It is usually carried by supports, normally steel shelf angles on each floor. These walls are generally 50 mm to 100 mm thick.

Fig: Non-load-bearing walls

(e) Precast joist roof

Precast joist roof is a building system in which precast reinforced cement concrete planks – rectangular slab elements – are placed on precast RCC joists. The roof gets completed with in-situ concrete poured over the haunches in planks and over the partially precast joists, thus ensuring monolithic action of individual precast elements.

Fig: Precast joist roof

(f) Precast facade

Precast sandwich panels enable the strict requirements for thermal insulation to be met. Concrete structures have great insulation qualities, keeping the building warm in cold weather and cool when it is hot, stabilizing the moisture and temperature inside. For the precast facade, a calculated age can be defined. One special feature of a precast facade is the panel joints

Fig: Precast facade

(g)Glass Fiber Reinforced Concrete (GFRC) - Glass fiber-reinforced concrete consists of high-strength, alkali-resistant glass fiber embedded in a concrete matrix. This is used especially for thin architectural cladding panels, but also for ornamental concrete such as domes, statues, planters, and fountains. Recently, decorative concrete artisans have discovered the benefits of GFRC for decorative panels (such as fireplace surrounds), concrete countertops, and artificial rock work.

Fig: Glass Fiber Reinforced Concrete (GFRC)

(h) Other elements

Precast staircase – Precasting staircase produces better surface finishes, avoids the inherent problems of casting complicated inclined sections on-site and provides rapid access to successive floors. They are cost-effective. The staircase can be designed with landing slabs also.

Fig: Precast staircase

Precast Storm Water Drain – Precast concrete drains allow for speedier construction of Drains with minimum site work. These drains range in widths from 200 mm to 855 mm and these can be customized as per your needs. They are produced in strict factory controlled conditions that ensure high quality. These types of drains are also used in Residential Layout and Water Lines in industries.

Fig: Precast Storm Water Drain

Precast box culverts – These are embedded in and surrounded by soil. Culverts come in many different shapes and sizes, including round, elliptical, flat-bottomed, pear-shaped, and box. Box culverts are used for intakes and outtakes, holding tanks, steam tunnels, corridor links, road crossings, service tunnels and utility trenches. These culverts are used at the road crossings or when the vehicles need to run over them.

Fig: Precast box culverts

Precast UG Sumps – A sump is an underground (or partially underground) tank that is popular in India. It is usually used for large water tank storage and can be built cheaply using a precast method. These are useful as they are cast monolithically and much preferred by all sectors.

Fig: Precast UG Sumps

Precast Septic Tanks – Precast concrete septic tanks are strong, watertight, environmentally friendly, and ideal for any residential waste management system. These precast septic tanks are produced to meet your required dimensions and are easily installed at your home as well.

Fig: Precast Septic Tanks

Precast toilets – This toilet is simple and ready to use immediately in few hours with all the multiple trade works involved in toilet markings such as waterproofing, plumbing, electrical, tiling, sanitary fittings, ventilators, doors, shower screens

Fig: Precast toilets

Different materials used for Precast Concrete Buildings

Precast elements could be made of reinforced or prestressed concrete. The behaviour of these two under service loads is dependent on the properties of the material composition as well as the manufacturing process. It is important to understand the nature of the materials used in the precast concrete buildings.

Given below is an overview of different materials used in precast concrete buildings

Cement, Aggregate and Steel

General-purpose- Ordinary Portland Cements [OPC] 43 grade [IS:8112] and 53 [IS:12269] are normally used in precast concrete construction. Avoid high silica cement as it suffers reversion and loses a large portion of its strength in warm and humid conditions.

Supplementary Cementitious Material [SCMs]

Supplementary cementitious materials are natural materials or industrial byproducts that exhibit cementitious behaviors when combined with either water or water and other compounds. SCMs enhance the results of ordinary portland cement (OPC) hydration reactions in concrete and are either incorporated into concrete mixes as a partial replacement for portland cement or blended into the cement during manufacturing. SCMs augment cement's actions and can improve fresh concrete characteristics, strengthen hardened concrete properties and reduce raw material costs.

Supplementary cementitious materials include fly ash, ground granulated blast- furnace slag, metakaolin and silica fume. They should comply with the requirements of the appropriate parts of IS; 3812 for fly ash, IS;12089 for GGBS and IS;15388 for silica fumes. The benefits of Supplementary cementitious materials include reduced cost, improved workability, lower heat of hydration, improved durability and chemical resistance.

Lightweight Aggregate concrete

Lightweight aggregate concrete can be made by injecting air into the composition of concrete. It will make the concrete contained with an air bubble which can reduce the weight and the density of concrete. The other way to produce this concrete is by replacing the aggregate by hollow, cellular and porous aggregate. The aggregates used in structural lightweight concrete may be a combination of fractions of bothlightweight coarse and fine materials and lightweight coarse material with an appropriate, natural fine aggregate. The advantage of Lightweight aggregate concrete is reduction in dead loads due to low density as compared to conventional concrete.

Fig: Lightweight Aggregate concrete

Fibers

Fibers can be used as reinforcement in precast concrete, either as a fiber-only solution or as a combined solution with conventional rebar reinforcement. Fiber-reinforced concrete (FRC) in precast construction increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Blends of both steel and polymeric fibers are often used in construction projects in order to combine the benefits of both products; structural improvements provided by steel fibers and the resistance to explosive spalling andplastic shrinkage improvements provided by polymeric fibers. In certain specific circumstances, steel fiber or macro synthetic fibers can entirely replace traditional steel reinforcement bars in reinforced concrete. This is most common in industrial flooring but also in some other precasting applications.

Fig: Fibers for Precast Concrete Buildings

4.3. Wall panel

A wall panel is single piece of material, usually flat and cut into a rectangular shape, that serves as the visible and exposed covering for a wall. Wall panels are functional as well as decorative, providing insulation and soundproofing, combined with uniformity of appearance, along with some measure of durability or ease of replaceability. While there is no set size limit for a piece of material fulfilling these functions, the maximum practical size for wall panels has been suggested to be 24 inches by 8 feet, to allow for transportation.

Use of wall panels can reduce construction costs by providing a consistent appearance to the panelled surface without requiring the application of paint or another finishing material. Wall panels may be finished on only one side, if the other side is going to be against a brick or concrete wall, or a comparable structure. Alternately, the panels may, if assembled to an appropriate framework, substitute for having any other kind of wall at all. Holes may be cut or drilled into a wall panel to accommodate electrical outlets and other devices coming out of the wall.

4.3.1Types of Wall Panels

(a) Rack Typesetting Panel

These are planks of 2400 – 3700 mm length and of a 125 – 300 mm width, their thickness is 8 to 12 mm. Such type is most in demand when covering small areas. It is a required crate of wood or metal for their installation. The panels fasten due to the presence of groove and tenon (or there are only slots and tabs that connect the two panels, but we'll have a gap in such case). The panel fixes to

the frame with staples or self-tapping screws (into the groove). For the manufacture of slatted typesetting pads often use chipboard, hardboard, PVC, and MDF.

Fig: Rack Typesetting Panel

(b) Tile Patterned Panel

Such panels are square-shaped, size is usually 30 x 30 to 98 x 98 cm. They are very usable to layout different figures, combining all sorts of shades and textures. Wall bracing for panels is usually produced by means of adhesive or capping, and they are fixed to each other using only grooves and the inserts in them. Chipboard, MDF, PVC, and MDF can also appear as the material for the manufacture of tile typesetting pads.

Fig: Tile Patterned Panel

(c) Sheet Wall Panels

These types of panels greatly facilitate the job of finishing walls by virtue of large sizes – from 1 22 to 2.44 m, with a thickness of 3 to 6 mm. The surface of these panels is a multilayer structure with the imitation of stone, wood, or tiles. Installation is performed using glue, and seams are hidden by moldings. For the manufacture of sheet metal wall panels producers often use impregnated with resins fiberboard.

Fig: Sheet wall panel

In addition to the existing three main types of decorative wall panels, there are also designs for the construction of interior walls and different partitions. These include both the concrete panel and a sandwich panel for modular houses, in the form of ready-made walls with a heater and a moisture and vapor barrier inside. Sandwich panels are mainly applied for villas and country houses.

4.3.2 Material used to Make Wall Panels

(a) Panels Made of Natural Wood

Most often made of oak, cedar, maple, or alder. It is ideal for housings, primarily due to its environmental friendliness. When installing such panels in rooms with high humidity (bathroom or kitchen), they should be chosen with a waxy coating panel, repelling water and dirt.

Fig: Panels Made of Natural Wood

(b) Chipboard panels (Chipboard)

The manufacturing process is based on the method of hot pressing of chips and sawdust. It is similar to wood, but less strong, since it is subject to temperature drops and high level of humidity, and therefore only suitable for the finishing of dry areas.

Fig: Chipboard panel

Fig: Hardboard Panels (Fibreboard)

(c) Hardboard Panels (Fibreboard)

Hardboard panels are also produced by hot pressing, but with the use of wood and other plant fibers. They are less prone to moisture, eco-friendly. However, they are not recommended for rooms with a high probability of direct hit water.

(d)MDF Panels

This comparatively new material, based on MDF (Medium-density fibreboard) boards by using dry pressing (press the fine wood shavings) at high temperature and pressure. The wood release lignin during heating. It serves as a connecting element. The material can withstand sufficient load (hanging lockers and shelves), and is resistant to moisture, has heat and sound insulation. It is hygienic, durable, in other words, it is rather qualitative. Moreover, there are even fire-resistant MDF types.

Fig: MDF Panel

(e) Glass Panels

Glass panels are designed to create photographic images that require a durable base. Therefore they have several disadvantages. But careful operation can last quite a long time, especially since manufacturers are interested to apply modern technology, which has a positive effect on the strength and protection of the glass surface.

Fig: Glass panel

(f) Vinyl Gypsum Panels (Vinyl Drywall)

This material has overgrown the well-known gypsum board today. It is mostly used to build walls, partitions, and even ceilings. The new material is the same drywall with the only difference that it is covered with vinyl instead of cardboard. This obstacle differs it favorably from its predecessor. Panels are endowed with the finished working surface with a certain pattern, and they are quite durable and reliable.

(g) 3D Panel

It is a new type of eco-friendly 3d wall panel made out of the fibrous residue of sugarcane. This fiber of crushed sugarcane stalks, remaining after raw sugar is extracted from the juice of the sugarcane by shredding it, is now the raw material, called bagasse, that forms the base of this easily installed eco-friendly product. The raw material used for these 3d wall panel is 100% recycled, compostable and is therefore 100% biodegradable.

Fig: 3D panel

It is the new design solution, facilitating the creation of individual style. It is made of “fashion panels” and bamboo – a material that represents a new decorative range of sculptural textured panels, painted in different colors using acrylic paint (glossy or matte finish). Panels can create a stunning effect and turn the interior space into a spectacular one.

(h) PVC Panels

The plastic wall panels are also new material made of a rigid polyvinyl chloride with a minimum amount of plasticizer. The panels can be safely used for almost any room, even in the shower, because they have a number of advantages: water-resistance, fire-resistance, they are hygienic, long-life. Plastic panels are the most popular option among their "classmates". This is due to several advantages

Fig: PVC panel

Properties of Plastic Pane

1. Environmentally friendliness. It should be noted that polyvinyl chloride is used for the production of food packages, tubes, and medical equipment. According to the rules of SES, finishing PVC panels are recommended for schools, sports gyms, and health facilities.
2. Fire resistance. It turns out that the ignition temperature for PVC panels is 370 C degrees, while the panels of fiberboard and particleboard light at 250 Celsius degrees. But that's not all: as shown by experiments, PVC panels emit 2 times less smoke when burning than the panels of chipboard and fiberboard. And when tested for toxicity was found that the products of chipboard and fibreboard combustion are one and a half times more toxic than their "classmate". Also, do not forget that finishing panels are classified as self-extinguishing materials.
3. Moisture resistance. Wall panels, thanks to a flat surface, are absolutely resistant to moisture, and the absence of pores contributes to the fact that bacteria and mold can't survive on the surface of the wall. That is why the material is often used in kitchens and for bathroom wainscoting.
4. Easy installation. It's no secret that the installation of such panels is not too difficult, it can manage even a not very experienced master. The material does not require any preparatory work and leveling the surface. Moreover, the damaged part of the structure can be easily replaced.
5. Decorative abilities. Plastic panels have a wide range of colors and shapes. There are variants with the applied pattern on the surface by means of thermal film. The material is able to decorate any surface thanks to this it is considered to be the most popular option of finishing.

   The Size of Plastic Panels

   Panel thickness can be divided into two types – a 5 mm and 8,9,10 mm. The second subtype (size 8-10 mm) constitutes of moldings of the same size.

1. Lining panels. The length of the panel is 3 m, width – 10 cm, and 12.5 cm for a rarer type (it has a double profile). The most popular are "European" with a wide lock and the other option is less popular with a narrow "Polka" lock. It produced mainly in white, rarer in color.
2. The most popular length of the plastic panels is 260, 270, and 300 cm; the width can be 15 up to 50 cm, but the most common size of 25 cm panel can be painted, lacquered, or has an application of the thermal film. An almost invisible seam of the assembled panel is the main difference from the lining panel.
3. PVC sheets can also be called PVC plates. The width of the sheet may vary in the 80-203 cm range, length – 150 to 405 cm. Foamed PVC sheets are the most popular, the upper layer of the panel may be toughened and smooth.

(i) EPS Sandwich panels

EPS Cement Sandwich Panel is a kind of lightweight energy saving wall partition material, which uses cement and cement fiber board as the face panel and filled with cement foam and EPS polystyrene foam particles in the center. Compared to a Masonry Concrete wall it is cheaper, stronger and also eliminates the complete step of plastering or curing. Thus reducing building costs.

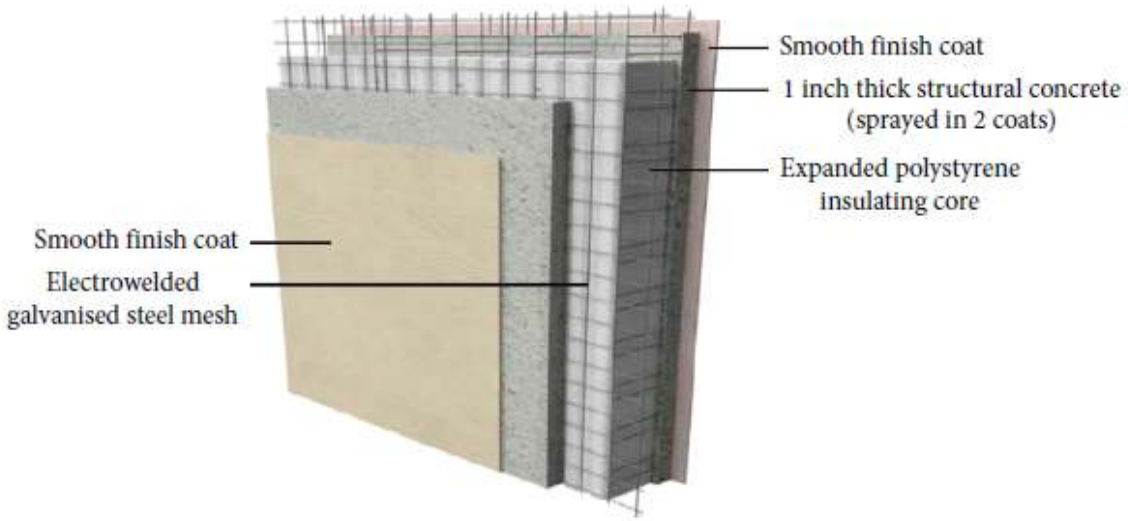


Fig: EPS Sandwich Pannel

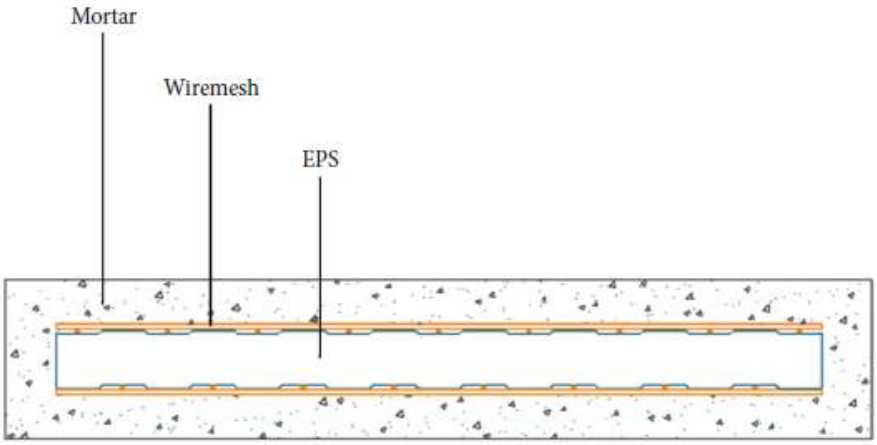


Fig: EPS sandwich wall panel Cross section

The Advantages of Wall Panels

By using wall panels as a finishing material, it is possible to avoid such preliminary issues as the alignment of the walls, as well as removing old plaster, wallpaper, and paint, ie pre-finishing of the walls. In addition, the installation of wall panels does not require special skills and master qualification. All you need to have is a stapler, nails, sticks of wood, and, in fact, the panels themselves. In addition, the wall panels provide excellent room and sound insulation, masking of computer, telephone, and other electrical cables. They do not need special care. The only thing needed is to wipe them once a month with any detergent or just a damp cloth. Damaged components can be easily replaced if necessary. But usually, the wall panels have a long life. They are durable, hygienic, and resistant to mechanical stress – all this will eliminate the need for annual cosmetic repairs.

Alternative Construction technologies for Flooing

(i)Vinyl Flooring

Vinyl Flooring is a versatile option that is available for people who want aesthetics at an efficient cost. Available in designs that simulate hardwood and stone finishes, vinyl is one of the relatively inexpensive options in India. Stain resistant and water resistant, these floors are quite durable. However, you will need to take special care to protect the floor from scratches. People looking for a warm material which replicates the appearance of cold flooring materials like hardwood and stone find this to be the ideal choice. One low point with vinyl is its susceptibility to discoloration when it comes in contact with rubber.

(ii) Bamboo Flooring

Bamboo is a naturally occurring material and the flooring done in this material resembles hardwood flooring. Bamboo flooring is fairly easy to maintain as it is water and stain-resistant and can bring a sophisticated feel to your home decor. The only factors that can mar the uber-chic look of a bamboo flooring are scratches which inevitably find a place on it. Humid weather can cause the Bamboo planks to plump up, so it's best used in moderately dry conditions.

(iii) Laminate Flooring

Laminate flooring is gaining popularity in India for its sheer durability and sturdiness. Easy to install, laminate flooring is fairly resistant to stains and water damage. However, leads to complete replacement as it cannot be re-polished or re-done. The diversity in the range of patterns and finishes makes it a good choice for various decor styles in Indian homes.

(iv) Linoleum Flooring

Linoleum is an eco-friendly flooring material produced from raw materials like linseed oil, cork, dust and resin. A cost efficient and highly versatile (in terms of design) flooring option, it's very popular in Indian homes. However, the soft surface is prone to dents and scratches from careless usage. For such reasons, one should use this type of flooring in areas of the house which see low traffic.

(v) Terrazzo Flooring

Terrazzo flooring is made up of chips of granite and marble placed in concrete or similar materials. Commonly called "mosaic flooring", these floors are durable enough to stand the test of time. You might remember them from your grandparent's home, as they were the norm in the decades gone by. Today, these traditional tiles have been re-invented and are now stain-resistant and easy to maintain.

(vi) Brick Flooring

Due to its cost effectiveness, brick flooring is widely popular in most parts of India. Known for their extraordinary strength, fire resistance, and extensive durability, bricks are easy to clean. However, bricks are highly porous and can chip off easily. Aesthetically versatile, brick flooring can be laid out in different patterns including staggered, basket weave and other arrangements. This is one of the best options if you are looking for a floor which maintains a moderate temperature to add a hint of a rustic style to your home.

(vii) Grasscrete

grass create is a method of laying some concrete flooring (mostly sidewalks, terrace gardens, and driveways) in such a manner that there are some open spaces in the patterns, allowing grass or other flora to grow. Not only does this limit the use of concrete, but it also looks great and aids in improved storm water absorption. By using even a little bit of these cost-effective and energy-efficient materials in some areas instead of concrete, you'll be lowering the environmental impact.

4.4 Alternative Technologies for Doors & Windows

Windows being essential and integral parts of homes and offices allow natural light and breeze and act as a barricade between outside noise and our homes.

(i) Polyvinyl chloride (PVC)

PVC comes in two basic forms: rigid (sometimes abbreviated as RPVC) and flexible. The rigid form of PVC is used in construction for pipe and in profile applications such as doors and windows.unplasticized polyvinyl chloride (uPVC) technology in windows and doors has a very reasonable cost. uPVC is becoming popular among homeowners. The material has exceptional home insulation properties but there are so many other benefits you stand to enjoy when you go for uPVC windows and doors. Let us look at some benefits of uPVC windowsanddoors:

Comfort Providing

Because of the draft proofing and insulating quality of uPVC windows they are able to maintain right temperatures throughout the seasons, thus offering high levels of comfort.

Fire safety enhancing

This is because the material is very difficult to ignite, especially when compared with wooden door frames. When you select the material for your doors and windows, be assured that the fire safety standards for your property are improved.

Reduced condensation

When the window panes are kept at warmer temperatures, water vapour is prevented from settling, due to the insulation properties of the frames. Therefore, there is no dampness that can cause problems.

Energy efficient

uPVC doors and windows have superior insulation properties that make them suitable for your home even during cold seasons. They retain heat during winters and cool the air during summers. This will greatly save you energy costs.

Affordable

The material is inexpensive, especially when you compare it with others, such as wood aluminium frames. You will manage to lower your costs by a huge percentage when you select the uPVC windows and doors.

Noise pollution

uPVC offers excellent glazing for your windows, in that, you will be in a position to keep out all unwanted noises from outdoors. The frames definitely create a calmer enjoyable environment, especially if you live in an area that is populated and and prone to all kinds of outdoor noises

Durable

uPVC does not warp or rot and this means that it is a material that it lasts longer than wood, which is easily affected by the weather. uPVC frames offer a much durable option and you will not have to worry about weather-related damages no matter where you live.

Low-maintenance

uPVC doors and windows have very little demands when it comes to maintenance mainly because they do not flake or rot. You will only need to do an occasional wipe to keep them looking good.

Aesthetically attractive

You will just love the appearance of your UPVC doors and windows. The material now comes in a wide array of finishes and colours, making it possible for you to find the perfect one to match your home.

(ii)Engineered wood

While making wooden boards from raw timber, a lot of wood gets wasted. This waste can be used to make engineered wood (which contains layers of wood and fillers like wood scraps and fibers), which can, in turn, be used to make walls, doors, etc

CHAPTER-5- BEST CONSTRUCTION PRACTICES IN RURAL ROADS

5.1.Introduction

Rural roads play an important role in the overall development of rural areas as access to social and economic infrastructure and services are the sine qua non of rural development. In an indirect way, rural roads influence the process of growth through changes in socio-economic attitudes of people by facilitating the dissemination of knowledge and reduction of inequalities leading to better quality of life. Rural roads are very essential to:

- promote and sustain agricultural growth
- improve basic health and hygiene
- provide access to schools and other educational opportunities
- provide access to economic opportunities
- create employment opportunities
- enhance democratic processes and bring people into national mainstream
- enhance local skills
- reduce vulnerability and poverty
- act as infrastructure multiplier

Rural Connectivity is perceived as one of the major components in increasing the agricultural output and earning capacity of the rural population. Improved rural connectivity will lead to marked improvement in the quality of life, by way of better educational facilities, improved health services, improved attendance of teachers as well as students etc. Accessibility also leads to improvement in governance and provision of other utility and emergency services.

1.1CLASSIFICATION OF ROADS

i. National Highways (NH)
ii. State Highways (SH)
iii. Major District Roads (MDR)
iv. Other District Roads (ODR)
v. Village Roads (VR)

i)National Highways (NH)

The National Highways Network of India, is a network of highways that is managed and maintained by Government of India. These highways measure over 70,934 km (44,076 mi) as of 2010, including over 1,000 km (620 mi) of limitedaccess Expressways. The National Highways Authority of India (NHAI) is the nodal agency responsible for building, upgrading and maintaining most of the national highways network. It operates under the Ministry of Road Transport and Highways. The NHAI often uses a public-private partnership model for highway development, maintenance and toll collection.

ii) State Highways (SH)

The state highways are the roads which link important cities, towns, district headquarters within the state and connecting them with national highways or highways of the neighboring states. These highways provide connections to industries/places from key areas in the state making them more accessible. The State Highways are maintained by the State Government.

iii) Major District Roads (MDR)

These are important roads within a district connecting areas of production with markets and connecting these with each other or with the State Highways & National Highways. It also connects Taluk headquarters and rural areas to District headquarters.

CLASSIFICATION OF RURAL ROADS

The rural roads are commonly classified as :

1. Other District Roads (ODR)
2. Village Roads (VR), which is further classified as
   - Panchayat Union roads
   - Panchayat roads

Other District Roads (ODR)

Other District roads are the roads serving rural areas and providing them with outlet to market centers, Taluk head quarters, block head quarters or major district roads, and would serve to connect villages with a population of 1000 and above or a cluster of villages. These roads are owned by Highways Department.

Village Roads (VR)

Village roads are roads connecting villages or cluster of villages with each other to the nearest road of a higher category. These roads are under the Control of Rural Development and Panchayat Raj Department.

Indian road network of 33 lakh Km is the second largest in the world and consists of :

Classification	Length(in Km)
Expressways	1000
National Highways	70,934
State Highways	1,31,899
Major District Roads	4,67,763
Rural and Other Roads	26,50,000

5.2.GEOMETRIC DESIGN

Geometric design standard of the rural roads are important parameters for constructing safe, comfortable and durable roads. These Geometric standards need not be restricted to the minimum values set out and milder standards than the minimum should be preferred where conditions are favorable and the cost is not excessive. Higher standard right in the initial stages may be warranted in cases where improvement of the road geometric at a later date is anticipated due to increased traffic.

5.2.1TERRAIN CLASSIFICATION

The general slope of the country classifies the terrain across the area. The terrain is an important parameter governing the geometric standards and the criteria given in Table 3.1 should be followed. While classifying a terrain, isolated stretches of varying terrain should not be taken into consideration.

Terrain Classification	**Cross Slope of the Country**	
Plain	0-10 %	More than 1 in 10
Rolling	10-25 %	1in 10 to 1 in 4
Mountainous	25-60%	1in 4 to 1 in 1.67
Steep	Greater than 60 %	Less than 1in 1.67

5.2.2DESIGN SPEED

Design Speed is a basic criterion for determining all geometric features like horizontal and vertical alignments, super elevation, extra widening of the pavement, length of the horizontal transition curve. The Design speed of roads depend upon 1) Class of road 2) Terrain The design speed for the rural roads should be taken as given in Table below

Design Speed (Km/hr)							
Plain Terrain		Rolling Terrain		Mountainous Terrain		Steep Terrain	
Ruling	Min	Ruling	Min	Ruling	Min	Ruling	Min
50	40	40	35	25	20	25	20

Normally ruling design speed should be the guiding criterion for the purpose of geometric design. Minimum design speed may, however, be adopted where site condition and cost does not permit a design based on Ruling Design Speed

5.2.3 BASIC PRINCIPLE OF GEOMETRIC DESIGN

As a general rule, geometric features of a road do not allow for stage construction. Improvement of features, like grade, curvature and widening of cross drainage works at a later date can be very expensive and sometimes impossible in remote and hilly area. It is, therefore, necessary that ultimate geometric requirement of rural road should be kept in mind right in the beginning. If stage construction is unavoidable, the permanent works, like, retaining walls, breast wall, and drain, which may have to be altogether rebuilt, may be constructed using dry masonry. Interceptor drain may be located well at the beginning and culverts provided to full width to avoid the need for their widening subsequently. The design standards recommended are absolute minimum. However, the minimum values should be applied only where serious restrictions are implied from technical or economical considerations. General effort should be to exceed the minimum values as far as possible. Road should be designed so as to have minimum turns and total number of curves in one kilometer should generally be less than 6.

5.2.4 CROSS-SECTIONAL ELEMENTS

(i) Width of Roadway or Formation

Width of formation or roadway is the sum of the widths of pavements or carriageway including separators (if any) and the shoulders. Formation width is the top width of the highway embankment or the bottom width of the highway cutting excluding the side drains.

Recommended Roadway Width

Terrain Classification	Road Width (m)
Plain and Rolling	7.5
Mountainous and Steep	6.0

(ii) Right of Way (Road Land Width)

Right of way is the area of land acquired for the road, along its alignment. The width of this acquired land is knows as land width and it depends on the importance of the road and possible future development.

Recommended Road Land Width

ROAD CLASSIFICATION	Plain and Rolling Terrain				Mountainous and Steep Terrain			
	Open Area		Built-upArea		Open Area		Built-up Area	
	Normal	Range	Normal	Range	Normal	Excep-tional	Normal	Excep tional
Rural Roads (ODR and VR), (m)	15	15-25	15	15-20	12	12	12	9

Note:

1) Additional land width as per requirement may be acquired at locations involving deep cuts, high banks and unstable or landslide prone areas.

2) The lower values of land width may be adopted where the traffic intensity is less than 100 vehicles per day, and where the traffic is not likely to increase due to situation, like dead end, low habitation and difficult terrain condition.

(iii) Building and control lines

In order to prevent overcrowding and preserve sufficient space for future road development, it is advisable to lay down restriction on building activity along the rural roads. Recommended standards for building lines and control lines are given in below.

Recommended Standards for Building and Control Lines

ROAD CLASSIFICATION	Plain and Rolling Terrain		Mountainous and Steep Terrain	
	Open Area	Built-up Area	Open Area	Built-up Area
	Overall Width Between Bldg. lines	Overall Width Between Control Lines	Distance Between Building Line and Road Boundary (Set-Back)	Distance Between Building Line and Road Boundary (set-back)
Rural Roads (ODR and VR), (m)	25/30*	35	3-5	3-5

*If the land width is equal to the width between the building lines indicated as above, the building line should be set-back by 2.5m from the road land boundary.

(iv) Carriageway width

The standard width of the carriage for plain and rolling as well as mountainous and steep terrain shall be 3.75 m. For rural roads, the carriageway width may be restricted to 3.0 m, where the traffic intensity is less than 100 motorized vehicles per day and where the traffic is not likely to increase due to situation, like, dead end, low habitation and difficult terrain conditions.

(v) Shoulder width

The width of the shoulder for rural roads in different terrain will be one half the differences between the roadway width and carriageway width.

(vi) Side slopes

Side slope for rural road where embankment height less than 3.0 m is given in below.

Side Slope For Rural Roads

Condition	Slope (H:V)
Embankment in Silty/gravelly soil	2:1
Embankment in clay or clayey silt or inundated condition	2.5:1 to 3:1
Cutting in silty/sandy/gravelly soil	1:1 to 1/2:1
Cutting in disintegrated rock or conglomerate	1/2:1 to ¼:1
Cutting in soft rock like shale	¼:1 to 1/8:1
Cutting in medium rock like sandstone, phyllite	1/12:1 to 1/16:1
Cutting in hard rock like quartzite, granite	Near Vertical

(vii) Roadway Width at Cross-Drainage Structures

It is difficult to widen cross-drainage structure at a later stage. Therefore, the roadway width should be decided very carefully at the planning stage itself. Causeway and submersible bridge are usually provided on rural roads. High-level bridge on rural road shall be provided only in exceptional cases on merit.

(viii) Camber

The camber on straight section of road should be as recommended as given in below

Camber for Different Surface Types

Surface Type	Camber (%)	
	Low Rainfall (Annual Rainfall< 1000 mm)	High Rainfall (Annual Rainfall >1000 mm)
Earth road	4	5
WBM and Gravel road	3.5	4
Thin Bituminous Pavement	3	3.5
Rigid Pavement	2	2.5

At super-elevated road sections, the shoulder should normally have the slope of same magnitude and direction as the pavement slope subject to the minimum cross-fall allowable for shoulder. The camber for earth shoulder should be at least 0.5 per cent more than that for the pavement subject to the minimum of 4 per cent. However, 1 per cent more slope than the camber for pavement is desirable.

5.2.5 HORIZONTAL CURVES

A horizontal highway curve is a curve in plan to provide change in direction to the central line of road. When a vehicle traverses a horizontal curve, the centrifugal force acts horizontally outwards through the centre of gravity of the vehicle.

The centrifugal force development depends on the radius of the horizontal curve and the speed of the vehicle negotiating the curve. This centrifugal force is counteracted by the transverse frictional resistance developed between the tyres and the pavement which enables the vehicle to change the direction along the curve and to maintain the stability of the vehicle.

The centrifugal force acting on a vehicle negotiating a horizontal curve has two effects: (i) Tendency to over turn the vehicle about the outer wheel and (ii)Tendency to skid the vehicle laterally.

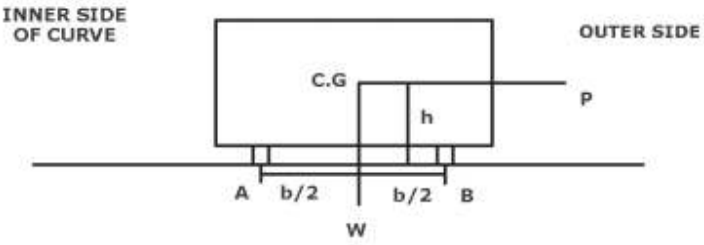
The analysis of stability of those two conditions against overturning and transverse skidding of the vehicle negotiating horizontal curves without super elevation are given below:

Over turning effect

The centrifugal force that tends the vehicle to over turn about the outer wheel B on a horizontal curve. The over turning moment due to centrifugal force P is PX h; This is resisted by the restoring moment due to weight of the vehicle W and is equal to W.b/2, where h is height of the centre of gravity of the vehicle above the road surface and b is the width of the wheel track of the vehicle. The stability condition for overturning will occur when Ph=Wb/2h. This means that there is danger of over turning when the centrifugal ratio P/W or v^2 /g*R attains a value of b/2h.

Transverse skidding effect

The centrifugal force developed also has the tendency to push the vehicle outwards in the transverse direction. If the centrifugal force P developed exceeds the maximum possible transverse skid resistance due to the friction, the vehicle will start skidding in the transverse direction. The equilibrium condition for the transverse skid resistance developed is given by: P=Fa+Fb= f (Ra+Rb) =Fw.



Overturning due to Centrifugal Force

F is the coefficient of friction between the tyre and the pavement surface in the transverse direction Ra and Rb are normal reaction at the wheel A and B such that (Ra+Rb) is equal to the weight w of the vehicle, as no super elevation has been provided in this case. Since P=f x W, the centrifugal ratio P/W is equal to 'f'. In other words when the centrifugal ratio attains a value equal to the coefficient of lateral friction there is danger of lateral skidding. Thus to avoid overturning and lateral skidding on a horizontal curve, the centrifugal ratio should always be less than b/2h. If the pavement is kept horizontal across the alignment, the pressure on the outer wheels will be higher due to the centrifugal force acting outwards and hence the reaction Rb at the outer wheel would be higher. The difference in pressure distribution at inner and outer wheels has been indicated in figure.10 When the limiting equilibrium condition for over turning occurs, the pressure at the inner wheels becomes equal to zero

SUPER ELEVATION

In order to counter act the effect of centrifugal force and to reduce the tendency of the vehicle to over turn or skid, the outer edge of the pavement is raised with respect to inner edge, thus providing a transverse slope throughout the length of the horizontal curve. This transverse inclination to the pavement surface is known as super elevation or cant or banking. The super elevation "e" is expressed as the ratio of the height of outer edge with respect to the horizontal width.

5.2.6.Horizontal Alignment

General guidelines

- The alignment should be as directional, fluent and matching well with the surrounding topography as for as possible and also to avoid abrupt changes.
- On new roads the curves should be designed to have the largest practical radius generally not less than the ruling value corresponding to ruling design speed give.
- Absolute minimum values based on minimum design speed may be used where economics of construction and site condition so dictates. The radii below the absolute minimum should not be provided.
- Straight section exceeding 3Km length should be avoided. A curvilinear alignment with long curve is of safety and aesthetic.
- Sharp curves should not be introduced at the end of long tangents, since these can be extremely hazardous.
- Curve should be sufficiently long and have suitable transition curves at either end to eliminate the shock due to application of centrifugal force. For deflection angle less than 1 degree no curve is required to be designed.
- Reverse curves may be needed in difficult terrain. Sufficient length between two curves shall be provided for introduction of requisite transition curve.
- To avoid distortion in appearance, the alignment should co-ordinate with longitudinal profile.

5.2.7 VERTICAL ALIGNMENT

The designer has to always keep an eye on economy in selecting the alignment and the longitudinal profile. It is general practice to follow as closely as possible the natural terrain profile. Desirably there should be no change within the distance of 150m.Two vertical curves in same direction with a short tangent should be avoided. The longitudinal profile should be coordinated suitably with the horizontal alignment. Decks of small cross drainage structures (culverts and minor bridges) should follow the same profile as the flanking road section without any break in the grade line.

Gradient

The rate of rise or fall with respect to the horizontal along the length of road expressed as ratio or a percentage is termed as the “gradient”. Gradient should be carefully selected keeping in view the design speed and terrain. While aligning a highway, the gradient is decided for designing the vertical curve. The engineer has to consider all aspects such as construction cost, practical problems in construction at the site, and the vehicle operation cost in such alternative proposals before finalizing the gradients. Gradients are divided into the following categories.

- Ruling gradient
- Limiting gradient
- Exceptional gradient
- Minimum gradient

Ruling gradient

It is a gradient which in the normal course must never be exceeded in any part of the road. Hence, ruling gradient is also known as design gradient. However, flatter gradients may be preferred wherever practicable. The selection of ruling gradient will depend upon several factors such as type of terrain, the length of the grade, the speed, pulling power of vehicles and presence of horizontal curves.

Limiting gradient

It is a gradient steeper than the ruling gradient, which may be used, in restricted lengths where keeping within the ruling gradient is not possible. However, the length of continuous grade line steeper than ruling value should be limited.

Exceptional gradient

It is a gradient steeper than the limiting gradient which may be used in short stretches only in extra-ordinary situations.

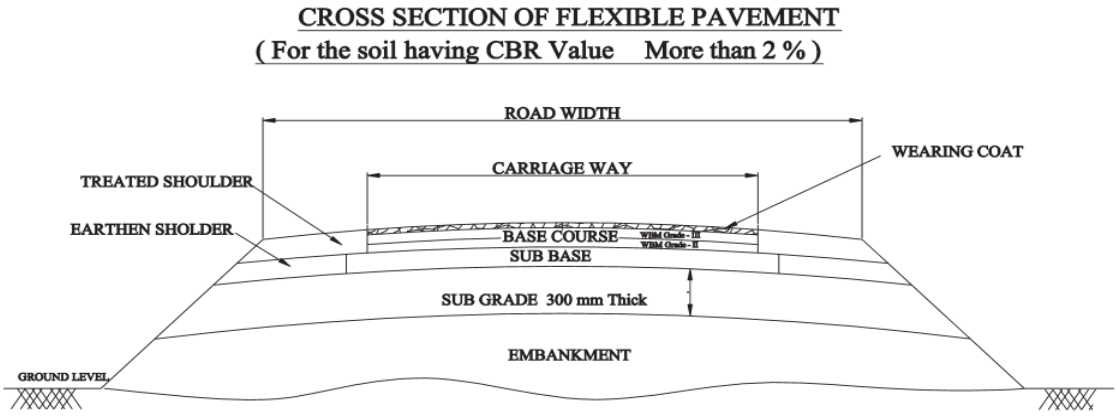
Minimum gradient

The road can be level, with little or no gradient in such cases there will be problems of drainage. Though the surface water can be drained off to the side drains by Providing proper camber on the pavement surface and cross slope on shoulders , a certain longitudinal slope is essential ,to drain the water along the drains, depending on the surface of the drains. Hence, it is desirable to have a certain minimum gradient. The minimum gradient would depend on rainfall runoff, type of soil, topography and other site conditions.

5.3 FLEXIBLE PAVEMENT

5.3.1. INTRODUCTION

Pavement structure consists of the prepared subgrade and the pavement component layers such as sub-base, base and surface course. The stability or the structural capacity of the pavement depends upon the pavement layer system including the subgrade. However, the road users are concerned about the riding quality, safety and other performance aspects of the road pavement rather than the pavement structure, design life etc. Hence, it is important to ensure the above requirments also while designing a pavement. The flexible pavements are constructed as a multi-layer system consisting of typical component layers, namely sub-base, base course, and surface course.



5.3.2. EMBANKMENT AND SUBGRADE CONSTRUCTION

(i) Embankment

Construction of embankment and preparation of subgrade are part of earth work. The main activities associated with construction are soil survey and identification of borrow area, construction of embankment and subgrade. The embankment may be constructed by rolling the earth / soil in relatively thin layers. Each layer should be compacted by suitable roller to a desired density before the next layer is placed. The height of road embankment depends on the highest flood level (HFL) in the area; generally 0.6 to 1m height above HFL or the GWL is to be ensured. Successful performance of an embankment depends as much on adopting standards of good compaction in construction as on careful pre investigations leading to selection of appropriate borrow material.

(ii) Subgrade

In Rural Roads, the top 30 cm of the cutting or embankment at the formation level shall be considered as subgrade. The subgrade should be will compacted to utilise its inherent strength and prevent permanent deformation because of additional compaction by traffic.

Specification for embankment and Subgrade

The material used in embankments, subgrades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the engineer. Such material shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ subgrade. The following material shall be considered unsuitable for embankment:

- Materials from swamps, marshes and bogs
- Peat, log, stump and perishable material, any soil classified as OL, OI, OH or Pt in accordance with IS: 1498
- Materials susceptible to spontaneous combustion
- Materials in a frozen condition
- Clay having liquid limit exceeding 70 and plasticity index exceeding 45
- Materials with salts resulting in leaching in the embankment
- Expansive clay exhibiting marked swell and shrinkage properties ('free swell index' exceeding 50 when tested as per IS: 2720-Part 40) shall not be used as fill material. Where expansive clay with free swell index less than 50 is used as a fill material.
- Any material with a soluble sulphate content exceeding 0.5 per cent by mass, when tested accordance with BS:1377-1975 Test 9, shall not be deposited within 500mm from concrete surface.

The size of coarse material shall ordinarily should not exceed 75 mm when placed in embankment and 50 mm when placed in subgrade. However the engineer may permit the use of coarser material if he is satisfied that the same will not present any difficulty as regards placement and compaction of fill material. The maximum particle size shall not be more than two thirds of the compacted layer thickness.

A 100% Standard Proctor Compaction should be attained in the top 30cm of the subgrade. For clayey soil, the minimum compaction for subgrade should be 95% of the Standard Proctor Compaction and the compaction should be done at moisture content 2% in excess of the optimum value. The subgrade in embankment is compacted in two layers, usually to a higher standard than the lower part of the embankment.

Where the CBR of the subgrade is less than 2% a capping layer of 100mm thickness of material with a minimum CBR of 10% or geo-textile, if found economical, is to be provided in addition to the sub-base required for CBR of 2%. If the subgrade CBR is more than 15%, there is no need to provide sub-base.

(iii) SUB-BASE (Granular)

It is a layer of selected material placed on the subgrade compacted to 100% of maximum dry density for the material determined as per IS:2720 (Part 7). Generally it consists of locally available, relatively low strength inexpensive material. The principal function of sub-base is to distribute the stresses over a wider area of the subgrade imposed by traffic and to ensure that no subgrade material intrude into the base course and vice versa.

When the subgrade is silty or clayey and the annual rainfall of the area is more than 1000mm, a drainage layer of 100mm over the entire formation width should be provided.

a.Coarse sand sub base (Drainage Layer)

The coarse to medium sand sub-base gives comparatively more effective drainage to pavement, where the embankment is clayey or black cotton soil. Sand layer shall be provided as a part of subbase over the compacted subgrade layer where annual rainfall is more than 1000 mm or CBR value less than 2. The sand layer shall normally be in 100 to 150 mm compacted thickness (necessary arrangements shall be made for local confinement of sand). The coarse to medium sand for construction of a drainage layer shall conform to given in Table

Grading of coarse to medium sand for Subbase

IS Sieve	Per cent passing
11.2 mm	100
5.6 mm	80-100
2.36 mm	70-90
180 micron	<5

The sand conforming to specified grading shall be spread uniformly and evenly upon the prepared sub grade in required quantities. Immediately following the spreading of sand, watering shall be done and rolling shall be started with vibratory roller of approved type at OMC.

b. Gravel Roads

Gravel/Soil-Aggregate is natural gravel or a mix of crushed stone, crushed gravel, crushed slag, moorum, sand, fine sized particles or combination there of depending on the grading and plasticity requirements for use in base or surface course for rural roads.

Specification:

The material to be used shall be graded and shall contain a fair proportion of all the particle sizes together with sufficient fines to provide proper cohesion as per technical grading limits. The compation shall be at least 100% of the maximum dry density for the material determined as per IS:2720 (Part 7). The Liquid Limit when determined according to IS:2720 (Part 5), shall not exceed 25 and the PI shall not exceed 6.

(iv) BASE COURSE

The base course materials should be of good quality so as to withstand high stress concentrations which develop immediately under the wearing surface. Since bituminous surface consist only of a thin wearing course, the upper surface of the base must be sufficiently smooth and true to profile to provide a good riding surface.

The different types of base course which are commonly used are:

a) Water Bound Macadam (WBM)

b) Wet Mix Macadam (WMM)

c) Crusher Run Macadam Base (CRMB)

a) Water Bound Macadam (WBM)

WBM Consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary, and water laid on a properly prepared subgrade/sub-base/base or existing pavement, as the case may be and finished in acordance with the requirments of these Specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer. The thickness of base shall not be less than 150 mm.

Specification

Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates of any other naturally occuring aggregates, such as, kankar and laterite of suitable quality. Materials obtained from rocks, such as, Phyllites, Shales or Slates, etc, shall not be permitted in WBM construction. Materials other than crushed slag shall be used in sub-base courses only. If the water absorption value of the coarse aggregate is greater than 2 per cent, the Soundness test shall be carried out on the material delivered to site as per IS:2386 (Part 5).

Screenings (Fill Material)

Screening to fill voids in th coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where economic considerations so warrant, predominantly non-plastic material (other than rouded river borne material) may be used for this pupose provided liqued limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent. The Screenings shall not contain any of the undesirable constituents listed in 1.1.2 of the which would render it unsuitable as a fill material.

The use of screenings shall be omitted in the case of soft aggregates, such as, brick metal, kankar, laterite, etc. as they are likely to get crushed to a certain extent under rollers.

Binding Material :

Binding material to be used for water bound macadam as filler material meant for preventing ravelling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 for sub-base/base course and 4 to 10 for surfacting course as deternmined in accordance with IS:2720.

The quantity of binding materials, where it is to be used will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of WBM will be 0.06-0.09 cum/10 sqm. The quantity shall be in the range of 0.08- 0.10 cum/10 sqm for 100 mm compacted thickness. Table 4.8 gives the quantities of materials (loose) required for 10 sqm for subbase/base course with compacted thickness of 100 / 75 mm.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction, etc.

Application of binding materials may not be necessary when the screenings used are of crushable type

b) Wet Mix Macadam (WMM)

Wet mix macadam construction is an improvment over the conventional water bound macadam providing speedy and more durable construction. It differs from the water bound macadam in that graded aggregates and granular materials are mixed with predetermined quantity of water in accordance with the specifications to form a dense mass which is spread and rolled to approved lines, grades and cross-section to serve as pavement course(s).

Specification

WMM consists of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-grade/subbase or a WBM layer. The thickness of a single compacted layer of WMM shall not be less than 75 mm. When vibratory roller or other type of approved compacting equipment is being used, the compacted thickness of single layer may be increased up to 200 mm. The aggregates shall conform to the grading given in Table

Grading requirements for Wet Mix Macadam (WMM)

Sieve Size	Percent by Mass Passing IS Sieve Grading Designation
53.00 mm	100
45.00 mm	95-100
26.50 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600 micron	8-22
75 micron	0-8
Material finer than 425 micron shall have Plasticity Index (PI) not exceeding 6	

c) Crusher Run Macadam

This work shall consist of furnishing, placing and compacting crushed stone aggregates in accordance with the requirements of the Specification and in conformity with the lines, grades, thicknesses and cross-sections shown on the plans or as directed by the Engineer.

(v) BITUMINOUS SURFACING

A. Prime Coat

Prime coat is a spray application of a single coat of low viscosity liquid bituminous material on top of the top most granular layer of the base course. Prior to applying the primer,the surface shall be carefully swept or brushed clean of dust and loose particles.

Bituminous primer should be slow setting bitumen emulsion, use of cutback being restricted to areas having subzero temperature or for emergency operations.

Specification :

Sub Section 502, Specifications for rural roads of MoRD gives details of prime coat. Bitumen emulsion shall be used as prime coat. Use of cutback bitumen should be restricted. The requirement of the prime coat for different types of base coarse is given in Table

The Requirement of Viscosity and Quantity for Priming

Porosity	Type of Surface	Viscosity at 60° C (centistokes)	Quantity per 10 sqm. (Kg)
Low	WMM, WBM	30-60	7-10
Medium	Gravel base	70-140	9-12
High	Stabilised base	250-500	12-15

Bituminous primer shall not be applied to a wet suface or during a dust stom or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10oC. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present.

B.Tack Coat application

Tack Coat is the application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of a bituminous mix.

The binder used for tack coat shall be Rapid Setting Bitumen Emulsion Grade RS1 complying with IS:8887. The use of cutback bitumen (Medium Curing grade) as per IS:217 shall be restricted only for sites at sub-zero temperature or for emergency applications.

Bituminous primer shall not be applied to a wet suface or during a dust stom or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10oC. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

Rate of application of Emulsion for Tack Coat

Type of Surface	Quantity in kg per sq.m area
Bituminous surface	0.20 to 0.25
Dry and hungry bituminous surfaces	0.25 to 0.30
Primed granular surface	0.25 to 0.30
Unprimed granular base	0.35 to 0.40
Cement concrete pavement	0.30 to 0.35

C.

Bituminous Surfacing Courses

The various types of thin bituminous surfacing may be classified into the following:

(i) Premix Carpet (PC)
(ii) Seal coat
(iii) Surface Dressing (SD)
(iv) Mixed Seal Surfacing (MSS) or Closely graded Premix Carpet
(v) Bituminous Macadam
(vi) Modified Penetration Macadam

(i) 20 mm Thick Open-graded Premix Carpet

Open-graded Premix Carpet consist of the preparation, laying and compaction of a premix surfacing material of 20 mm thickness composeed of small-sized aggregate premixed with a bituminous binder on a previously prepared base to serve as a wearing course.

The binder shall be penetration grade bitumen of a suitable grade S-65/90, appropriate to region, traffic, rainfall and other environmental conditions satisfying the requirements of IS:73-1992. Where modified binder is specified, Subsection 512 of Specifications for rural roads of MoRD should be followed.

The PC consists of open graded coarse aggregate (0.18 m3 of size passing 20 mm and retained 10 mm sieve and 0.09 m3 of size passing 12.5 mm and retained 6.3 mm sieve for 10 m2 area), premixed with 9.5 kg and 5.1 kg bitumen respectively for 10 m2 area laid over the prepared surface with prime coat and/or tack coat.

(ii) Seal Coat

This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and cross fall (camber).

The seal coat shall be any of the three types mentioned below:

Type A : Liquid seal coat comprising of an application of layer of bituminous binder followed by a cover of stone chips.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

Type C : Premixed seal coat comprising of an application of 6.7 mm size stone chips premixed with bituminous binder.

(iii) Surface Dressing

This work consists of the application of one coat or two coats of surface dressing, each coat consisting of a layer of bituminous binder sprayed on a previously prepared base, followed by a cover of stone chips rolled in to form a wearing course.

One coat or two coats of surface dressing shall be decided on the basis of anticipated traffic and climatic conditions.

Surface dressing serves as a thin wearing coat, and protection against easy entry of surface water into the pavement structure for both open graded bituminous courses as well as granular pavement surface such as WBM. Surface dressing can be applied in one application (single coat) or in multiple applications (two or more coat). In two coat surface dressing first coat is laid with large size stone chippings with higher application of binder content. The smaller chippings of the second application is normally fit into the interstices between the large chippings of the first application, thus giving the combined layer much greater stability.

(iv) Mix Seal Surfacing

This work shall consist of the preparation, laying and compaction of mix seal surfacing material of 20 mm thickness composed of graded aggregates premixed with a bituminous binder on a previously prepared surface, in accordance with the requirements of these Specifications, to serve as a wearing course. No Mix Seal Surfacing layer shall, however, be placed directly over WBM base.

Mix seal surfacing shall be of Type A or Type B as specified in the Contract documents.

(v) Bituminous Macadam

This work shall consist of construction in a single course having 50 mm to 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base.

The binder content shall be in between 3.1 to 3.5 percent depending upon the type of aggregate. The layer of bituminous macadam shall be covered with wearing coat or subsequent layer within 48 hours. If there is any delay, surface may be covered by sand seal.

(vi)Modified Penetration Macadam (MPM)

The work shall consist of construction of one or more layers of compacted coarse aggregates (in accordance with the requirments of these Specificatons to be used as a base course on roads) with alternate applications of binder and key aggregates. Thickness of an individual course shall be 50 mm or 75 mm.

It is applied when a thin premix carpet (20-25 mm) laid directly on granular surface gets deteriorated fast if the traffic is reasonably high. Thicker treatments, like DBM and BM are costly and for level of traffic on rural roads does not justify the same. Therefore, it is essential to have transition/intermediate layer like penetration macadam, modified penetration macadam and built up spray grout. Built up spray grout involves use of mechanically crushed metal. However, the requirement of the crushed metal is reduced in the case of penetration macadam and modified penetration macadam, and also cost effective. In such a situation, it is desirable to replace the top layer of WBM by one layer of MPM.

5.4. Flexible Pavement Design

5.4.1 INTRODUCTION

The road structure may be divided into four major components, viz., land, earthwork, pavement and cross drainage works. The pavement constitutes nearly one-third to one-half of the total cost of the road. Therefore, very careful consideration should be there for the choice of the type of pavement and its design.

5.4.2.1.Objectives of pavement design:

1. To provide a stable surface under wheel loads
2. To provide good riding surface
3. To have durability
4. To have cost effectiveness

5.4.2.2. Requirements of Pavements:

1. Stable, Non-yielding surface
2. Limited elastic deformation
3. Least rolling resistance
4. Smooth riding surface
5. Transfer stresses over a wider area on soil subgrade
6. Capillarity arrest

5.4.2.3. The factors which govern the selection of the type of the pavement are:

1. Initial (construction) cost
2. Availability of good materials locally
3. Cost of maintenance or rehabilitation during service
4. Technology of construction required and its availability

5.4.2.4. Recommended design approach for the design of Rural Roads

For purposes of pavement structural design, the low volume rural roads are divided into the following categories:

a. Gravel/Aggregate-surfaced roads (Unpaved Roads);
b. Flexible Pavements (Paved Roads); and
c. Rigid Pavements

The international experiences, for the past several decades, with gravel roads notably in the USA show that the maximum traffic level upto 100,000 Equivalant Standard Axle Load (ESAL) applications can be considered for Gravel Roads, while the practical minimum level (during a single performance period) is 10,000. Below ESAL applications of 10,000, even Earthern Roads are suitable.

Gravel is defined as a mix of stone, sand and fine-sized particles used as a subbase, base or surfacing on a road, the material specifications for use in these layers being available in Clauses 401 and 402 of the MORD specifications for rural roads. When the required gradation of gravel is not available in a natural form, the blending of naturally occurring materials in the required proportions may be resorted to.

For low volume rural roads, still carrying a sizable volume of truck and bus traffic, the maximum number of ESAL applications considered for flexible or rigid pavement is upto 1 million ESAL applications. The practical minimum traffic level for a flexible or rigid pavement is about 50,000 ESAL applications during a single performance period.

The Serviceability rating system from 5 to 1 as per the PMGSY Operations Manual 2005(in terms of Present Serviceability/Condition Index) has been adopted. For the low volume rural roads in India, a Terminal Serviceability Index (i.e., the lowest index that will be tolerated before rehabilitation / strengthening or reconstruction becomes necessary) of 2.0 is considered suitable. The thickness of gravel / aggregate – surface roads (unpaved roads) has been based on the following criteria:

(i) The serviceability loss over the design life is limited to 2.0, taking the initial serviceability index to be 4.0 just before opening the road to traffic, and the terminal serviceability of 2.0 when rehabilitation will be due, with or without provision of an overlay.

(ii) The allowable depth of rutting under 3m straight edge does not generally exceed 50 mm.

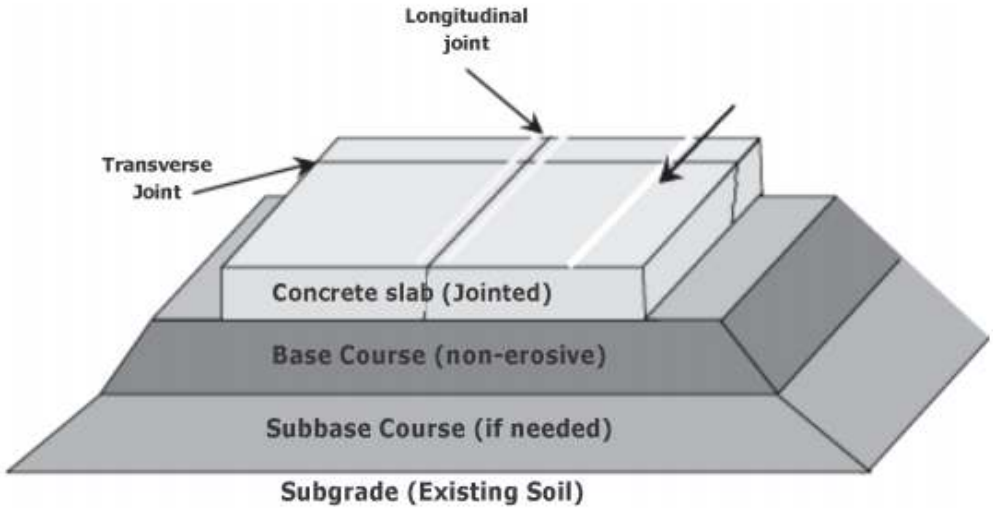
The design traffic parameter has been expressed in terms of the cumulative 80 kN (8.16 tonnes) ESAL applications during the design life. Seasonal variations by way of enhanced traffic during the harvesting seasons have also been considered. For the evaluation of the subgrade strength for new roads, the selection of moisture content has been dealt with scientifically instead of always insisting on 4-day soaked CBR values. For the rehabilitation or upgradation of existing rural roads, the use of Dynamic Cone Penetrometer (DCP) (mm/blow) has also been recommended for insitu subgrade strength evaluation.

5.5 RIGID PAVEMENT DESIGN

5.5.1. INTRODUCTION

In spite of vigorous attempts over the past fifty years, a large proportion of India's villages remain unconnected by an all-weather road. Renewed efforts are now being made to overcome this deficiency. It is observed that rural roads have a very low volume of traffic, generally of the order of less than 150 vehicles per day, consisting mostly of rural transport vehicles like agricultural tractors/trailers, light goods vehicles, buses, animal drawn vehicles, motorised two-wheelers and cycles. Some of the rural roads may also have light and medium trucks carrying sugarcane, timber, quarry materials etc. Another feature common to rural roads is that their maintenance is neglected, because of paucity of funds and poor institutional set-up. The design of pavements for rural roads should recognize these factors.

Concrete pavements offer an alternative to flexible pavements especially where the soil strength is poor, the aggregates are costly and drainage conditions are bad (as in portions of the roads passing through villages and water-logged areas). The choice depends on these factors and the life-cycle cost. Concrete pavements may be conventional screed-compacted pavements, Roller Compacted Concrete Pavements (RCCP) or Interlocking Concrete Block Pavements (ICBP).



Cross section of Rigid Pavement

5.5.2. FACTORS GOVERNING DESIGN

a. WHEEL LOAD

The legal axle load in India being 102 kN, the pavement may be designed for a wheel load of 51 kN. However, for link roads serving isolated villages where the chances of heavy trucks operating are non-existent, a design wheel load of 3 kN may be considered.

b. TYRE PRESSURE

The tyre pressure may be taken as 0.7 MPa where a wheel load of 51 kN is considered and 0.5MPa where a wheel load of 30 kN is considered.

c. DESIGN PERIOD

The design methodology given in these guidelines is based on wheel load stresses. The repetitions of wheel loads and the consumption of fatigue, which form the basis of design in IRC:58-2002, need not be considered for the very low volume of traffic encountered on rural roads. Concrete pavements designed and constructed as per the guidelines contained in this document will have a life of not less than 20 years, as evidenced from the performance of roads constructed in the past in the country.

INTENSIVE TRAINING PROGRAM (ITP-TWD)

Hand book for Tribal Welfare Engineering staff

OBJECTIVES :-

At the end of training the Engineering Technical staff will be able to_ _ _ _ _

- Explain the Functions of TWED & role of TWED staff
- Explain Tender Procedures in the department and various steps involved in Contract Administration
- Indentify suitable building components where Alternate technology constructions can be adapted in School Buildings Construction
- Identify Good Practices in Construction of Rural Roads in tribal areas
- Describe Green Building concepts
- Acquire skills in construction practices to suite to obtain IGBC ratings for a School Building
- List out Construction deficiencies in different Layers of Rural Road Construction

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