TENDER No: SRO/CON/ETS/010 dated 18.06.2018

FOR

e-Tender for Construction of Athletic Track and Development of Play fields for permanent campus of the RGUKT, Basar - 504107, Nirmal District, Telangana State.

VOLUME – II

Special Conditions of Contract
&
General Technical Specifications
&
Drawings
SPECIAL CONDITIONS OF CONTRACT (SCC)

The following special conditions shall be read in conjunction with General Conditions of Contract. The provisions in Special Conditions of Contract shall take precedence over General Conditions of Contract.

INTRODUCTION

Tender for Tenders for Construction of Athletic Track and Development of Play fields for permanent campus of the RGUKT, Basar - 504107, Nirmal District, Telangana State.

The following clauses of Special Conditions of Contract (SCC) shall be applicable for this contract:

These Special Conditions of Contract shall be read in conjunction with General Conditions of Contract, Instructions to Tenderers (ITT), Notice Inviting Tenders (NIT), Bill of Quantities (BOQ), Tender Drawings, and Technical Specifications & Other Tender Documents

1. GENERAL

   The work in general shall be carried out as per the latest Andhra Pradesh detailed specifications with up to date correction slips, unless otherwise specified in the nomenclature of the individual item or as per specifications provided with this tender. Any item not covered under these specifications shall be carried out as per approved specifications. In case any item is not covered in any of these documents, the same shall be carried out as per the latest BIS Code in practice or as per approval of Engineer in Charge of EPIL.

   Where any portion of special conditions of contract is repugnant to or at variance with any provision of the Instructions to Tenderers and General Conditions of contract and/or the other documents forming part of the contract then unless a different intention appears the provision of the Special Conditions of Contract shall be deemed to over-ride the provisions of the general conditions of contract and/or the other documents forming part of the contract only to the extent such repugnant/variations in the special conditions of contract as are not possible of being reconciled with the provision with Instructions to Tenderers or General Conditions of contract and/or the other documents forming part of the contract.

2. DEFINITIONS

   Definitions as per General Conditions of Contract (GCC) shall be amended or the following definitions appended as under

   The words “Site” in various clauses of General Conditions of Contract (GCC) and other documents of this Tender shall mean “Tenders for Construction of Athletic Track and Development of Play fields for permanent campus of the RGUKT, Basar - 504107, Nirmal District, Telangana State.”

   a) Wherever the sentence “the cost to be incurred by the Contractor shall deemed to be included in the quoted rates of the BOQ items” as mentioned in various General Conditions of contract is appearing, the same shall be read as “the cost to be incurred by the contractor shall deemed to be included in the BOQ rates including the percentage quoted on the BOQ rates / amount.”
b) Wherever in General Conditions of Contract, approval of EPIL / Executing Agency is mentioned, it shall include the approval from the Owner's representative also.

3. **SCOPE OF WORK**

   The scope of work, in general, includes Tenders for Construction of Athletic Track and Development of Play fields for permanent campus of the RGUKT, Basar - 504107, Nirmal District, Telangana State. (hereinafter referred to as “Works”) as per Technical specifications, Designs, Drawings, BOQ, Instructions and Terms and Conditions given in Tender Documents and its amendments/clarifications etc. received from Client/ EPI from time to time.

4. **Order of Precedence**

   Clause 42.1 of GCC stands amended as under:

   In case of difference, contradiction, discrepancy, dispute with regard to Conditions of Contract, Specifications, Drawings, Bill of Quantities and Rates quoted by the Contractor and other documents forming part of the contract, the following shall prevail in order of precedence

   a. Contract Agreement which includes NIT, Special Instructions to Tenderer/Bidder, Memorandum.
   b. Letter of Intent, detailed letter of Work Order along with statement of agreed variations and its enclosures.
   c. Description in Bill of Quantity / Schedule of Quantities
   d. Special Conditions of Contract.
   e. General Technical Specification as given in the Tender Documents.
   f. General Conditions of Contract.
   g. Drawings
   h. Telangana State Specifications and SoR, AP state technical specifications / building data BIS specifications and CPWD specifications

5. **TIME SCHEDULE & PROGRESS**

   The clause No. '43.2' of General Conditions of Contract (GCC) of this Tender document shall be read as under:

   “The contractor shall also furnish within 10 days of date of letter/ telegram of Intent a Time and Progress Chart (Bar Chart) for completion of work within stipulated time. This time & progress chart shall be based on the milestones given hereunder. This will be duly got approved from EPI. This approved Bar Chart shall form a part of the agreement. Achievement of milestones as well as total completion has to be within the time period allowed. The milestones to be applicable for this contract shall be as under:

   The contractor shall also ensure achievement of following milestones in terms of financial targets, failing which intermediate liquidity damages shall be liable to be effected as per terms and conditions in GCC;
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Time allowed for Achievement of financial Targets (since inception of project)</th>
<th>Financial Achievement During the Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 Month</td>
<td>25%</td>
</tr>
<tr>
<td>2</td>
<td>3 Months</td>
<td>70%</td>
</tr>
<tr>
<td>3</td>
<td>5 Months</td>
<td>100%</td>
</tr>
</tbody>
</table>

5.1 Defect Liability Period:

Defect Liability Period as per GCC Clause No: 74.0 stands modified as Twenty Four Months (24 Months) instead of twelve months (12 months).

6. PROGRESS REPORTS AND SCHEDULES

Clause no. 43.6 of General Conditions of contract (GCC) shall be read as under:

The contractor shall submit to the Engineer-in-charge by the third day of every Month two copies of a report duly updated along with BAR/CPM/PERT Chart in an approved Proforma showing the progress made in construction of the works during the previous month.

7. REVIEW MEETINGS

During the progress of the works the Contractor or his authorized representative is expected to participate in the monthly review meetings and/or any special meetings as instructed by the Engineer-in-Charge. Any revision of the schedule of completion as a result of the review, will be submitted by the Contractor to the Engineer-in-Charge within a week who will approve it after due scrutiny. The Contractor will adhere to the revised schedule thereafter. No additional payment shall be made to the Contractor for any multiple shift work or other incentive methods contemplated by him in his work even though the EPIL/RGU KT approves the time schedule. The approval of the revised time schedule shall not in any way relieve the contractor from the terms & conditions of contract contained elsewhere in the contract documents. The Contractor has to submit weekly, monthly progress reports along with Photographs of different activities at site without any fail.

8. QUALITY ASSURANCE PROGRAMME

The last paragraph of clause no. '81.0' of General Conditions of contract (GCC) shall be read as under:

“The quality formats/ checks lists for different components of the work shall be as directed and approved by the Engineer-in-Charge. The approved formats shall be adopted for manufacturing, installation, inspection & commissioning of the work. These filled in formats shall be prepared in two copies and duly signed by representatives of contractor and EPIL. All the costs associated with printing of formats and testing of materials required as per Technical Specification or as desired by Engineer-in-charge shall be borne by contractor without any extra cost to EPIL and shall be deemed to be included in contractor’s quoted rates in the schedule/ Bill of quantities (BOQ).”
The Quality Control Forms and Checklists provided in the General Conditions of Contract (GCC) shall be modified by Engineer-in-Charge as per requirements of quality checks on the basis of Technical Specification & codal requirements, shop drawings etc.

The formats for quality checks/inspection shall be developed and submitted to Engineer-in-Charge for approval and shall be adopted after approval.

9. ARRANGEMENT OF CONCRETE

The Contractor has to submit the design mix for the work to be executed and other requirements will be as decided by Engineer in charge.

Concrete mix design shall be carried out by the contractor at his own cost from approved laboratory before starting the work.

10. PROTECTION OF SITE

The contractor is required to make arrangements for protection of site at which the works are to be executed from inundation due to water, floods or other such situations etc. No extra payments shall be allowed for any delay in execution of the works on account of water standing at site of works and no claims for an extra rate shall be entertained on these accounts unless otherwise expressly specified.

11. DAMAGE AND LOSS

Damage to the existing structures: Any damage to the existing structures during the execution of work shall be made good by the contractor at his own cost and the site of work left clean and tidy on completion. Rectification/reinstatement/making good etc. shall conform to the standard materials originally used in the work and finished work shall match with existing work in all respects to the entire satisfaction of the Engineer-in-charge.

12. SITE DOCUMENTS

The following site documents shall mainly be maintained by the contractor at site:

a) Copy of contract documents and drawings.
b) Computerized bill format.
c) Site Order Book.
d) Material testing registers/ Quality Inspection Reports.
e) Measurement books on computerized format.
f) Progress bar chart.
g) Sample approval register.
h) Visitors register.
i) Hindrance Register
jj) Work Diary.
k) Stage passing Register
ll) Any other detail and specific requirement as deemed necessary
In case the above are not provided at site within 10 days of placement of LOI, EPIL shall provide the same and necessary expenditure shall be deducted from the bills for documents.

13. **MINOR DETAILS OF CONSTRUCTION:**

The rates quoted by the Contractor shall be deemed to cover for all the minor details / requirement of construction which may not have been specifically shown on the drawings or given in particular specifications, BOQ, but are required as per established engineering practice.

14. **DISCREPANCY IN DRAWINGS:**

The Contractor shall be responsible to ensure co-relation in Structural drawings Architectural Drawings and Bill of Quantities, before commencement and execution of work. In case of discrepancy, the Contractor shall bring it to the notice of the Engineer-in-Charge for clarifications within 28 days of the issue of Letter of Acceptance. In the event of such discrepancy arising during the course of the work for which drawings are given after the date of issue of Letter of Acceptance, the Contractor shall seek clarifications within 7 days of receipt of such drawings. The Contractor shall take into consideration such contingencies in the completion schedule. The Contractor shall not be eligible for any extension of time for such occurrences. The decision of the Engineer-in-Charge shall be final and binding in this case. The bidder is also advised to visit the site and seek clarifications before submitting his bid.

15. **EMPLOYER NOT TO SUPPLY ANY MATERIALS:**

The Employer shall not supply or procure any material, for use on works, to the Contractor and he has to make his own arrangements for supplying, procuring, transportation and storage of all such materials required for the construction works at his own cost.

16. **WITNESSING OF TESTS BY THE ENGINEER-IN-CHARGE**

The Contractor shall make under the direction and in the presence of Engineer-in-charge, such tests and inspections as have been specified or as the engineer-in-charge shall consider necessary to determine whether or not the full intent of requirements of the specifications and the other related contract documents have been fulfilled. In case the work does not meet the full intent of the specifications and the other related contract documents it shall be rectified by the Contractor at no extra cost and the Contractor shall bear all the expenses for any further tests considered necessary.

17. **PROJECT COMPLETION**

The contractor shall inform in writing at least One month in advance about the date of completion of work so that arrangements for taking / handing over are organized by EPIL along with the OWNER well in time. The completion certificate shall be issued by EPIL in consultation with the OWNER after having fully satisfied themselves about the satisfactory completion of the work.
18. During post construction phase the contractor shall be responsible for carrying out the following activities but not limited to the following: Rectification of the defects promptly as pointed out by EPIL or Owner’s representative(s) during the Operation & Maintenance period.

Submission of “FINAL REPORT” of the completed project containing all technical & other related details.

19. The Contractor shall hold harmless and indemnify the EPIL and the OWNER against any claims or liability because of personal injury including death of any employees of the contractor arising out of or in consequence of the performance of this contract.

EPIL and the OWNER shall not be responsible for any loss or damage to property of any kind belonging to the Contractor or its employees, servants or agents during execution of the contract.

In case of any damage or loss of property relating to the WORK (S) that may happen, the Contractor shall at his own cost, repair and make good the same in conformity with the Contract. Adequate insurance coverage shall be obtained by the Contractor for this purpose.

20. PLANTS & MACHINERY:

All plant and machinery required for execution of work shall have to be arranged by the contractor at his own cost.

21. EQUIPMENTS FOR TESTING OF MATERIALS & CONCRETE AT SITE LABORATORY

All necessary equipment for conducting all necessary tests shall be provided at the site laboratory by the contractor at his own cost.

The contractor shall procure the following quality control equipment, which is required for day-to-day laboratory tests and also to procure any other equipment, which is essential during the work period.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Testing machine for determining crushing strength of cement concrete cubes</td>
<td>1 No</td>
</tr>
<tr>
<td>b</td>
<td>Liquid limit and Plastic limit apparatus</td>
<td>1 No</td>
</tr>
<tr>
<td>c</td>
<td>Slump test apparatus</td>
<td>1 No</td>
</tr>
<tr>
<td>d</td>
<td>Physical balance</td>
<td>1 No</td>
</tr>
<tr>
<td>e</td>
<td>Electrically operated oven</td>
<td>1 No</td>
</tr>
<tr>
<td>f</td>
<td>Proctor’s compaction equipment</td>
<td>1 No</td>
</tr>
<tr>
<td>g</td>
<td>Sand replacement method equipment</td>
<td>1 No</td>
</tr>
<tr>
<td>h</td>
<td>Bitumen extraction test equipment</td>
<td>1 No</td>
</tr>
<tr>
<td>i</td>
<td>Aggregate Impact value test equipment</td>
<td>1 No</td>
</tr>
<tr>
<td>j</td>
<td>Flakiness and elongation index equipment</td>
<td>1 No</td>
</tr>
<tr>
<td>k</td>
<td>Set of IS sieves</td>
<td>1 Set</td>
</tr>
<tr>
<td>l</td>
<td>Camber board and straight edge</td>
<td>2 Sets</td>
</tr>
</tbody>
</table>

22. DOCUMENTS FOR SUPPLY ITEMS

For supply items in Part III of BOQ the Supplier shall submit the following documents to EPIL.
a) Warranty Cards.
b) Manufacturer’s test certificate.
c) Any other test certificate from an external laboratory to determine the Technical specifications.
d) Catalogues
e) Pollution Control Certificates.
f) Documents required for registration of vehicle with the local transport Authority and other interstate movement of vehicle.
g) List of recommended spares with specification and costs thereof.
h) Operation & Maintenance manuals.

23. **TECHNICAL STAFF FOR WORK** : Clause 27.0 of GCC shall be amended as below:

The following minimum key personnel would be deployed on the project by the Contractor for day to day execution and supervision of its works during the entire duration of the project. The minimum number and level of Engineers, Supervisors and other personnel to be deployed by the contractor during Maintenance/defect liability period shall be as directed by EPI. In case contractor fails to deploy adequate number of personnel at site/ office, EPI after giving seven days notice shall engage the required personnel solely at the risk and cost of the contractor and debit the cost of the same to the account of the contractor.

<table>
<thead>
<tr>
<th>SR. No.</th>
<th>Position</th>
<th>Qualification</th>
<th>Total Experience</th>
<th>Experience in Civil Project</th>
<th>Number required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineers</td>
<td>Engg. Graduate Civil</td>
<td>08</td>
<td>03</td>
<td>01</td>
</tr>
<tr>
<td>2</td>
<td>Supervisors</td>
<td>Engg. Diploma Civil</td>
<td>08</td>
<td>03</td>
<td>02</td>
</tr>
<tr>
<td>3</td>
<td>Computer Operator</td>
<td>Qualified [Proficient in use of MS Project / Primavera].</td>
<td>02</td>
<td>-</td>
<td>01</td>
</tr>
<tr>
<td>4</td>
<td>Lab Engineer/ Technician</td>
<td>Degree/Diploma in Civil Engineering</td>
<td>05</td>
<td>02</td>
<td>01</td>
</tr>
<tr>
<td>5</td>
<td>Quantity Surveyor</td>
<td>Degree/Diploma in Civil Engineering</td>
<td>05</td>
<td>02</td>
<td>01</td>
</tr>
</tbody>
</table>

NOTE: Other supportive staff shall also be adequately deployed by the Contractor as per the requirement of work OR as directed by the Engineer-in-charge.

24. **SECURITY DEPOSIT CUM PERFORMANCE GUARANTEE**:

Clause 9.0 of GCC shall stands modified as under:

5(Five pint zero) % shall stands modified to 2.5 (Two point Five) %. All other conditions of the clause shall remain unchanged.

25. **RETENTION MONEY** : Clause no. 10.0 of GCC shall be modified as under:

The Retention Money shall be deducted from each running bill of the Contractor at 7.5% (five percent only) of the gross value of the Running Account bill. The Earnest Money Deposited by the tenderer in the form of Demand Draft will be treated as part of the Retention Money. The Retention Money shall be refunded to the Contractor after expiry of defects liability period or on payment of the amount of the
final bill whichever is later. If the amount of Retention Money deduction in cash is more than Rs.10.00 lakhs (Rupees Ten lakhs only), the excess amount can be refunded to Contractor against submission of Bank Guarantee of equivalent amount from a Nationalised bank / Scheduled Bank in the prescribed proforma of Performance Guarantee of EPI.

Out of 7.5 %, Initial 5% of the retention money shall be refunded to the contractor after completion of the Project successfully upto the satisfaction of EPI/ CLIENT along with final Bill and balance 2.5% shall be released completion after defect liability period.

26. MOBILIZATION

No mobilization advance shall be paid. Hence Clause no. 8.0 of General Conditions of Contract (GCC) stands deleted

27. SECURED ADVANCE:

No SECURED ADVANCE shall be paid. Hence Clause no. 35.0 of General Conditions of Contract (GCC) stands deleted

28. PRICE ADJUSTMENT : Not applicable

29. TAXES AND DUTIES : The following shall be also read with clause no 13 of GCC:

1. The Contractor must be registered with GST and should have valid GSTN number in the concern state.

2. The contractor must submit in compliance of GST Act, the invoices in GST compliant format, failing which the GST amount shall be recovered/ adjusted by EPI without any prior notice, from the next bills or from available dues with EPI.

3. The contractor must upload returns in the GST periodically so as to avail ITC credit by EPI failing which the GST amount shall be recovered/ adjusted by EPI without any prior notice from the next bills or from available dues with EPI.

4. Rates quoted in this contract are inclusive of all taxes, duties, Levies, Cess etc., including GST, Labour Cess etc., as applicable.

5. In case of any reduction in rate of GST or other taxes in feature or the project getting exemption status prior to the last date of bid submission or afterwards, the subcontractor shall pass on the benefit to EPIL immediately, failing which EPIL shall have right to recover the differential amount from the amounts due to the subcontractor. Further, in case of any increase in rate of GST or other taxes in future or the project losing exemption status prior to last date of bid submission or afterwards, the said increase of taxes shall be paid/reimbursed to the subcontractor, subject to the condition that the reimburses the said increased taxes to EPIL.

Bidder while quoting the rates in the tender must also consider the ITC credit applicable for the works, if any.

6. Labour cess @ 1% of value of work, as applicable on date as per the directions of Government of Andhra Pradesh, is included in the quoted rates. Contractor must submit
documentary evidence in compliance/payment of labour cess failing which EPI shall deduct the same from the bills and deposit with statutory authorities.

7. **Seigniorage Charges**: Seigniorage charges as applicable are included in the quoted rates. Contractor must submit documentary evidence in support of payment of Seigniorage charges to the Government, failing which the same will be recovered as per rules from the work bills of the contract, based on the theoretical requirement of material as per GO Ms. No 198 of Industries and commerce (MI) Dept. dated 13-08-2009 at the rates decided by Govt. time to time, and deposit the same with statutory authorities.

30. It is the responsibility of the contractor for getting the approval from the local statutory authorities such as town planning / municipal authorities / electricity board/fire department etc. and other department for the works executed at site as per the approved plans and designs etc. The statutory fees payable for approval shall be made directly to the local government department / state authorities by EPIL/RGUKT authorities. Other incidental expenditure if any shall be borne by the contractor and no reimbursement will be made for the same.

31. The contractor is responsible for obtaining the connection for water supply, sewer connection, electric connection and other connections if any from local authorities/state Electricity board.

32. Concrete mixed design shall be carried out by the contractor at his own cost from approved laboratory before starting the work.

33. For items not covered under any of the specifications mentioned in Tender Documents, the works shall be carried out as per APSS Specifications/manufacturer’s specifications/General Engineering Practice and/ or as per directions of Engineer-in-Charge. The rate for such extra work shall be derived as as follows:

   a) If the item is available in TG SOR 2017-18, contractor has to execute the item with the same rate.

   b) If the item is not available in SOR 2017-18 and similar item is available, rate for such extra work shall be derived from the similar item by adding or deleting the differences.

   c) If the rate for any item is not possible to derive as mentioned above, the rate for which shall be derived by analyzing as per the prevailing market rates.

34. The Contractor shall procure Reinforcement steel and Structural steel required for the works directly from the Manufacturer.

35. The contractor should invariably obtain necessary manufacturers test certificates from the suppliers of steel and cement for each and every consignment and furnish them to the Engineer-in-charge before use on works.

36. The original bills of procurement should be submitted to the Engineer-in-charge for making payment of the item. The contractor shall purchase the steel and cement on the name of work, the name of contractor and furnish the same to the Engineer-in-charge. The steel and cement without the above two names will not be accepted on the works.
37. If any difference is observed on carriage inwards, carriage outwards and theoretical requirement of steel and cement for finished works, recovery at double the rate will be effected from the contractors bills for the quantity varied above the allowable limits.

38. Three sets of As Built Drawings shall be submitted by the contractor in hard and soft copies.

39. For all Schedule BOQ items the nomenclature /rates/ unit of TG SOR items shall be followed. In case any ambiguity is observed in Scheduled BOQ items relevant TG SOR item will hold good.

40. The contractor will arrange to carry out total station survey before start of work and after completion of work, if requires, at his own cost.

41. All the cost of travel, lodging, boarding etc. towards visits by Client, their Consultant etc. to the manufacturing units/works for the inspection of materials, equipment etc. under the scope of work of Contractor shall be borne by the Contractor.

42. From clause 28.3 of GCC providing Furnished Office Accommodation & Mobility and Communication to be provided to the EPI staff is deleted.

43. Payments: Clause no 44.0 of GCC stands amended as follows,

Payments for the work done shall be released to Contractor within Fourteen (14) working days of receipt of RA Bill duly certified by EPI's representative including mobilization advance and secured advance etc. and after deducting recoveries if any. Recovery / Adjustment of the Mobilization advance and secured advance shall be as per the terms of contract / APSS norms.

The final bill payment to the Contractor shall be released 30 days after submitting Sales Tax clearance certificates, EPF clearance certificate, all other clearances, approvals, certificates etc. as per agreement for the “Works” and as per statutory requirement.

The Contractor shall have no claim on EPI in case the payments are delayed by the client due to any reason whatsoever.

44. The Contractor shall be fully responsible to complete the “Works” in workmen like manner to the satisfaction of Client and EPI by maintaining high standard of quality and precision as per ‘Tender documents’, Agreements, Terms & Conditions, Specifications, Drawings etc., within the contractual completion period and within their quoted rates/amount. In case Client reduces or increases scope of work related to Contractor’s portion of work, the same shall be binding on Contractor and the Contractor has to execute the same at rates quoted by them.

45. In case Contractor is awarded the “Works” and fails to execute the same as per agreed schedule of progress of work and as per specified quality and/or lags behind in activities required for timely completion of “Works”, as determined by EPI/Client, then EPI shall give 15 days written notice to Contractor to achieve the specified quality and/or to deploy adequate resources to the satisfaction of EPI, for timely completion of “Works”. Upon expiry of the notice period, if Contractor fails to achieve specified quality and/or fails to take action for timely completion of “Works”, then EPI shall have option to withdraw the remaining work partly or in full from Contractor and get the same executed at the risk and cost of the Contractor from alternative agency/agencies besides encashment of the guarantees submitted by the Contractor. The decision of EPI in this regard shall be final and binding on the Contractor.
46. The Contractor confirms that it holds EPF Code number, GSTIN on Works contract number, Service tax registration number, PAN (Permanent Account Number of Income Tax) etc. and shall be responsible for depositing EPF subscription and contribution for labour and staff employed by it on the “Works” and Service tax, other taxes, duties and dues etc. as per statutory requirements and documentary evidence of same shall be provided to EPI. The Contractor shall also be responsible for labour welfare and for arranging labour and other licenses/ permits/ clearances etc. for the project at their own cost. The Contractor shall comply with all the requirements as per labour laws/acts. All the records in this regard shall be maintained by Contractor as per statutory requirements and rules and shall be produced by the Contractor on demand if required.

47. The Contractor shall be responsible for obtaining all approvals from EPI/Client with regard to quality of materials & workmanship and measurements etc. for their portion of work. The Contractor shall be responsible for reconciliation of issue material, if any. In case there is any shortfall of free issue items found during reconciliation, recovery at double the cost of materials prevailing at that time of recovery shall be made from the Contractor’s due payment.

48. In case of non-approval of Contractor’s association for the Project by the Client and/or by the corporate office of EPI due to any reasons whatsoever at any stage of the “Works”, the Contractor shall have no claim on EPI.

49. The Contractor shall plan and execute the “Work” in his scope of work in such a manner that the other works, connected with the “Works” of the Contractor, but not included in Contractor’s scope of work do not get affected / delayed.

50. Quantity variation : Clause no. 69.1(v) of GCC shall be modified as under

The quantities indicated in the BOQ are tentative. However contractor has to execute the works as per drawings and site conditions. Payment will be released for the work executed as per the rates quoted by contractor even if the quantities increases or decreases upto any extent.

51. The Contractor shall deploy sufficient plant & equipment of the required capacity and in good working condition for completion of the works in stipulated time with required quality. The equipment should either be owned by the Contractor or hired/leased. The deployment of equipment by Contractor shall be as decided by EPI and the same shall not be less than the minimum deployment stipulated, if any, for execution of “Works” and as per schedule agreed with EPI. The Contractor shall make arrangement for regular maintenance including preventive and breakdown maintenance and maintain stock of essential spares at site/near to site so as to ensure minimum breakdown time of equipment. The equipment once brought to site shall not be allowed to be removed without the consent of EPI. In case the Contractor fails to deploy sufficient equipment to the satisfaction of EPI or in case of prolonged breakdown of equipment, EPI at its sole discretion shall arrange the required equipment and debit all the related costs including ten percent overheads of EPI and shall recover the same from the due payments of Contractor, including from its bank guarantees available with EPI.

52. Contractor shall ensure compliance with all Central, State and Local Laws, Rules, Regulations etc. as applicable or may be applicable during the course of execution, maintenance etc. of the “Works” and shall indemnify EPI against any claim or damages whatsoever on such accounts. The Contractor shall keep EPI indemnified at all times against infringement of any Patent or Intellectual Property rights.
53. EPI is an ISO-9001 and ISO-14001 Company. The conditions of the ISO as applicable should be followed by the Contractor for implementation & maintaining the established procedures of EPI for this purpose. Following documents have been provided by EPI to Contractor & Contractor confirms receipt of the same:

a. Quality, Environmental, OH & safety policy
b. Environmental, Objectives & Targets
c. Operational control – Noise
d. Operational control – wastage
e. Operational control – energy
f. Operational control – Deforestation
g. Operational control – Plantation of trees
h. OH & S. management objects & targets

54. Project sign board to be supplied and erected at the site office as per the drawing enclosed at Annexure – I, no extra cost.

55. The work executed by Contractor shall be subject to audit and quality control checks from Quality Control Division & Technical Audit of EPI, Client, Inspecting Agency of the Client and Chief Technical Examiner of Central Vigilance Commission, Govt.of India. In the eventuality of any defect/ sub standard works as brought out in the report or noticed otherwise at any time during execution, maintenance period etc., the same shall be made good by the Contractor. In case Contractor fails to rectify the defect/sub-standard work within the time period stipulated by EPI, EPI shall get it rectified at the risk and cost of Contractor and shall recover the amount from the dues of the Contractor.

56. EPI has agreed to award the work to the Contractor on the basis of details regarding experience profile, financial standing, credentials, fulfillment of statutory obligations, etc. of Contractor submitted by Contractor to EPI. In case, at a later stage if it is found that the Contractor has submitted incorrect, false details and credentials resulting in apprehensions on the capabilities of Contractor with regard to quality & timely completion of works, financial capabilities etc, EPI can terminate this order solely at its option. In this eventuality the Contractor shall be liable for the losses suffered by EPI and further Contractor shall have no claim on EPI, whatsoever.

57. BARRICADING OF SITE

The contractor has to make their own arrangements for barricading of proposed site as per Site conditions. No payment shall be made on account of barricading the above mentioned work at site. The barricading of site shall be as per the directions of Engineer In-charge. The material used for barricading of work shall be taken back by contractor after completion of the work with written permission of Engineer In-charge.

58. CONCILIATION AND ARBITRATION

The “Parties” shall make efforts to settle disputes, if any, amicably. Only if amicable settlement is not possible, the same shall be referred to the sole arbitration of the Chairman & Managing Director (CMD) of EPI or the person appointed by the CMD, EPI and the decision of the
arbitrator shall be final and binding on the “Parties”. Arbitration will be according to “Conciliation & Arbitration” clause of GCC. (Refer below)

General Conditions of Contract (GCC) Sub Clause no.76.1 and 76.3 of Arbitration Clause no.76.0 are amended as given below. Sub Clause no.76.2 will remain the same.

76.0. ARBITRATION
76.1 Before resorting to arbitration as per the clause given below, the parties if they so agree may explore the possibility of conciliation as per the provisions of Part III of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation (Amendment) Act, 2015. When such conciliation has failed, the parties shall adopt the following procedure for arbitration:

i) Except where otherwise provided for in the contract, any disputes and differences relating to the meaning of the Specifications, Design, Drawing and Instructions herein before mentioned and as to the quality of workmanship or materials used in the work or as to any other questions, claim, right, matter or things whatsoever in any way arising out of or relating to the Contract, Designs, Drawings, Specifications, Estimates, Instructions, or these conditions or otherwise concerning the works of the execution or failure to execute the same whether arising during the progress of the work or after the completion or abandonment thereof shall be referred to the Sole Arbitrator appointed by the Chairman & Managing Director (CMD) of Engineering Projects (India) Limited (EPI) or any other person discharging the functions of CMD of EPI. The person approached for appointment as Arbitrator shall disclose in writing circumstances, in terms of Sub-Section (1) of Section (12) of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation (Amendment) Act, 2015 as follows:

a) Such as the existence either direct or indirect, of any past or present relationship with or interest in any of the parties or in relation to the subject-matter in dispute, whether financial, business, professional or other kind, which is likely to give rise to justifiable doubts as to his independence or impartiality; and

b) which are likely to affect his ability to devote sufficient time to the arbitration and in particular his ability to complete the entire arbitration within a period of twelve months.

The Arbitrator shall be appointed within 30 days of the receipt of letter of invocation of arbitration duly satisfying the requirements of this clause.

ii) If the arbitrator so appointed resigns or is unable or unwilling to act due to any reason whatsoever, or dies, the Chairman & Managing Director aforesaid or in his absence the person discharging the duties of the CMD of EPI may appoint a new arbitrator in accordance with these terms and conditions of the contract, to act in his place and the new arbitrator so appointed may proceed from the stage at which it was left by his predecessor.

iii) It is a term of the contract that the party invoking the arbitration shall specify the dispute/differences or questions to be referred to the Arbitrator under this clause together with the amounts claimed in respect of each dispute.

iv) The Arbitrator may proceed with the arbitration ex-parte, if either party, in spite of a notice from the arbitrator, fails to take part in the proceedings.
v) The work under the contract shall continue as directed by the Engineer-In-Charge, during the arbitration proceedings.

vi) Unless otherwise agreed, the venue of arbitration proceedings shall be at the venue given in the “Memorandum” to the “Form of Tender”.

vii) The award of the Arbitrator shall be final, conclusive and binding on both the parties.

viii) Subject to the aforesaid, the provisions of the Arbitration and Conciliation Act, 1996 as amended by Arbitration and Conciliation (Amendment) Act, 2015 or any statutory modifications or re-enactment thereof and the Rules made there under and for the time being in force shall apply to the arbitration proceedings and Arbitrator shall publish his Award accordingly.

76.2 JURISDICTION:

The courts in Chennai alone will have jurisdiction to deal with matters arising from the contract.
ANNEXURE - I
GENERAL TECHNICAL SPECIFICATIONS

[TO BE INCORPORATED AS PER REQUIREMENT OF THE WORK PUT TO TENDER DULY QUOTING THE RELEVANT SPECIFICATION NUMBER OF APSS. BSI Code No. , MORT&H, etc. STANDARD SPECIFICATION NO.]
STANDARD SPECIFICATION FOR BUILDING WORK (AS PER A.P.S.S.) AND ROAD WORKS AS PER MORTH

All the items of work shall be executed as per the Standard Specifications laid down in APSS, the relevant I.S Codes of the Special Specification as indicated in Schedule - 'A' of the tender.

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EARTH / MURRUM FILLING WORKS

301. EXCAVATION FOR ROADWAY AND DRAINS

301.1. Scope
This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and waterways in accordance with requirements of these Specifications and the lines, grades and cross-sections shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and subgrade construction, suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

301.2. Classification of Excavated Material

301.2.1. Classification: All materials involved in excavation shall be classified by the Engineer in the following manner:

Soil
This shall comprise topsoil, turf, sand, silt, loam, day, mud, peat, black cotton soil, soft shale or loose murrum, a mixture of these and similar material which yields to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having dimension in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

Ordinary Rock (not requiring blasting) This shall include: rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone etc., which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting; macadam surfaces such as water bound and bitumen/tar bound; soling of roads, paths etc. and hard core; compact’ murrum or stabilised soil requiring grafting tool or pick or both and shovel, closely applied; gravel and cobble stone having maximum dimension in any one direction between 75 and 300 mm;

lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and
boulders which do not require blasting having maximum dimension in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

Hard Rock (requiring blasting) This shall comprise: any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required; reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and boulders requiring blasting.
Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

Marshy Soil

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

301.2.2. Authority for classification: The classification of excavation shall be decided by the Engineer and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

301.3. Construction Operations

301.3.1. Setting out: After the site has been cleared as per Clause 201, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of bench marks and other marks and stakes as long as in the opinion of the Engineer, they are required for the work.

301.3.2. Stripping and storing topsoil: When so directed by the Engineer, the topsoil existing over the sites of excavation shall be stripped to specified depths constituting Horizon "A" and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots, with approval of the Engineer.

301.3.3. Excavation - General: All excavations shall be carried out in conformity with the directions laid here in under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilized as decided upon beforehand.

While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion, water pollution etc. as per Clause 306, and take appropriate drainage measures to keep the site free of water in accordance with Clause 311.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/width excavated beyond the specified levels/dimensions on the drawings shall be made good at the cost of the
Contractor with suitable material of characteristics similar to that removed and compacted to the requirements of Clause 305.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place. If trees were removed, new trees shall be planted, as directed by the Engineer. The cost of planting new trees shall be deemed to be incidental to the work.

301.3.4. Methods, tools and equipment: Only such methods, tools and equipment as approved by the Engineer shall be adopted/used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

8.0 EARTH WORK IN FILLING

After clearing, stripping and consolidation of areas as specified in clause 6, spot levels at intervals and pattern as decided by Engineer-in-charge shall be taken jointly with the Contractor and Engineer-in-charge and filling shall commence only after the levels are signed by the Contractor as the token of his acceptance. Approved fill material shall be spread in uniform layers not exceeding 30 cms in loose depth. The contractor has to make his own approach and access roads from the borrow area to the demarcated filling areas. While the contractor may make use of such short cuts as may be available to him for earth movement from borrow areas to the filling areas, the Owner does not guarantee any pass way or the right of way for the Contractor other than available at site. No claim shall also be admissible to the Contractor on the account of his having taken longer leads or routes for earth movement, than envisaged by him, either due to any road cuttings, non-availability of routes, or any other grounds whatsoever. In case of total filling required in any area consists of earth both from borrow areas and available approved excavated material from within plant area, then joint levels, shall be taken before commencing filling with earth from borrow area. However earth from borrow areas required for filling can be used only after the available earth from within demarcated area has been utilized and clearance to this effect obtained from Engineer-in-charge.

All clods, lumps etc, shall be broken before compaction.

Successive layers of filling shall not be placed until the layer below has been thoroughly compacted to satisfy the requirements laid down in the specification.
Prior to rolling, the moisture content of material shall be brought to within plus/minus 2% of the optimum moisture content as described in IS:2720 part vii. The moisture content shall preferably be on the wet side for potentially expansive soil.

After adjusting the moisture content as described, the layers shall be thoroughly compacted by either sheep foot roller or power driven roller or vibratory roller as approved by Engineer-in-charge till the specified maximum laboratory dry density is obtained.

Each layer shall be tested in field for density and accepted by Engineer-in-charge subject to achieving the required density before laying the next layer. A minimum of one test per 500m2 for each layer shall be conducted.

If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-charge to obtain the required density.

The filling shall be finished in conformity with the alignment, levels, cross section and dimensions as shown in the drawing. Earthen embankment shall be filled 300mm on both sides, where height is more than 1m, and this extra filling shall be dressed, after compaction, in conformity with alignment, level, cross section and dimensions as shown in drawing to achieve proper compaction in the slope. No extra payment shall be made in this regards.

All the royalty payments etc. as deemed admissible to statutory/govt. authorities will be paid by contractor for all the earth brought for EPIL works. It shall be the responsibility for the contractor to produce all such payments, documents to Engineer-in-Charge during submission of running bill. At the end of work no objection certificate from relevant authorities will be submitted to ensure that EPIL is kept free from all encumbrances.

Extra material shall be removed and disposed off as directed by Engineer-in-charge.

Tolerances
General site grading including cutting and filling in depressions shall be carried out to within up down tolerance of +/- 5 cms of final lines grades and slopes.

Payment
Payment for filling shall be made on cubic metre of volume calculated on the basis of cross-section plotted from the levels of ground, where filling is to be carried out and the levels reached after filling is duly consolidated, volume being calculated by trapezoidal method.

No extra payment shall be made towards testing charges.

9.0 MISCELLANEOUS & ENABLING WORKS

The Land development work shall be commenced in following sequence.

a. Taking spot levels and marking grid pillars and clearing bushes & vegetation.
b. Identifying Borrow areas and obtaining laboratory results regarding nature of soil, Optimum moisture content (OMC) and max dry density.
c. Submission of earth filling and excavation procedure.
d. Earthwork in excavation and filling. The filling shall be done in layers not exceeding 300mm (loose) and compacted with 8-10T roller/vibro roller so as to achieve 95% dry density. The field testing shall be done for every layer per 500sqm.
e. The borrow area earth brought from outside should also be commenced simultaneously (only after it is ensured that the excavated earth within premises shall be utilized in filling fully). Whenever there is a change in source of earth, fresh laboratory test shall be carried out and submitted.
f. Proper watering should be ensured during filling and compaction operation so that moisture content is near OMC.
g. Party should ensure that all royalty and other cess are paid before earth is brought to site for filling operation.
h. The trees cut within premises should be uprooted up to 1m below ground level and the branches to be chopped to small sizes and stacked at designated place within premises.
i. Coordination with other contractors, creating front for others for execution of job.

10.0 SPECIFICATION FOR MURRUM FILLING

1.0 This covers the specification for external borrowed earth material i.e. MURRUM for land filling purposes..

2.0 Only Material considered suitable by EPIL shall be employed for the construction and that consider unsuitable shall be disposed of, as directed by Engineer-in-Charge, at contractors cost and no claim for compensation will be entertained

3.0 The contractor shall give 4 to 5 samples minimum to cover the best material available in around the vicinity to Engineer-in-Charge / EPIL prior to collection and use for approval. The test for following characteristic for all the samples shall be done in a laboratory / test house as guided by Engineer-in-Charge:

i) Mechanical analysis are grain size distribution as per IS:2720 part IV.
ii) Liquid limit as per IS:2720 part V
iii) Plastic limit as per IS: 2720 part V
iv) Moisture density relationship as per IS: 2720 part VII

4.0 The murrum used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious materials.

5.0 Murrum approved by EPIL shall only be used for filling purpose. Non plastic material will not be permitted

6.0 Murrum having standard proctor laboratory maximum dry density of less than 1.8 gms/cc shall not be used. The murrum shall have a Plasticity Index of 7-17(medium Plastic) and not more than 20%Fines, i.e., Clay. Particle size grading shall be 20mm and down size.
7.0 Care shall be taken to see that waste material from murrum is disposed of in such a manner that there is no likely hood of its getting mixed with the material proposed to be used for filling.

8.0 The contractor has to make own approach and access roads in the borrow areas(Outside Plant Premises) and to the demarcated filling area(Inside Plant Premises).

9.0 All the royalty payments etc. as deemed admissible to statutory / govt. authorities will be paid by contractor for all the murrum brought for EPIL works. It shall be the responsibility for the contractor to produce all such payments, documents to Engineer-in-Charge during submission of running bill. At the end of work no objection certificate from relevant authorities will be submitted to ensure that EPIL is kept free from all encumbrances.

10.0 Approved murrum material shall be spread in uniform layers not exceeding 20 cm in loose thickness and watered as per OMC.

11.0 After checking the moisture through moisture tester by calcium carbide method in field for OMC, the layers shall be thoroughly compacted by vibratory roller as approved by Engineer-in-Charge till 95% of Standard proctor maximum laboratory dry density is achieved. Each layer shall be tested in field for density and accepted by EPIL subject to 95% of Standard proctor maximum laboratory dry density being achieved. A minimum of 1 test per 500 sq. mt. of compacted area in field shall be conducted for dry density. Required equipments like Moisture Tester, Oven, Electronic weighing machine, proctor apparatus shall be supplied by Contractor.

12.0 Successive layers of filling and watering will not be permitted until the layer below has been compacted thoroughly to satisfy the requirements of the specifications. If the layer fails to meet the required density, it shall be reworked till the required density is achieved.

13.0 The filling shall be finished in conformity with alignment levels, cross section and dimension as shown in the drawing. Earthen embankment shall be filled suitably on both sides to achieve the required compaction and this extra filling shall be dressed after compaction, in conformity with alignment, levels, cross section and dimensions as shown in the drawing. No extra payment shall be made in this regard.

14.0 The excavated soil and / or unusable debris from excavation shall be loaded, transported safely and unloaded at designated spots as specified/ as per local bye laws. In case of disposal within the premises, the soil/debris after unloading shall be levelled and dozed keeping a distance of at least 5m from the Compound wall to give a uniform appearance. No extra payment shall be made in this regard.

Payment
Payment for filling shall be made on cubic metre of volume calculated on the basis of cross-section plotted from the levels of ground, where filling is to be carried out and the levels reached after filling is duly consolidated, volume being calculated by trapezoidal method.
No extra payment shall be made towards testing charges.

305. EMBANKMENT CONSTRUCTION

305.1. General
305.1.1. Description: These Specifications shall apply to the construction of embankments including subgrades, earthen shoulders and miscellaneous backfills with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments, subgrades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

305.2. Materials and General Requirements

305.2.1. Physical requirements:

305.2.1.1. The materials 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 materials 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 types of material shall be considered unsuitable for embankment:

Materials from swamps, marshes and bogs;

Peat, log, stump and perishable material; any soil that classifies as OL, 01, 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; and

Materials with salt resulting in leaching in the embankment.

305.2.1.2. Expansive clay exhibiting marked swell and shrinkage properties ("free swelling index" exceeding 50 per cent when tested as per IS: 2720 - Part 40) shall not be used as a fill material. Where expansive clay with acceptable "free swelling index" value is used as a fill material, subgrade and top 500 mm portion of the embankment just below subgrade shall be non-expansive in nature.

305.2.1.3. Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS: 1377 Test 10,
but using a 2:1 water-soil ratio shall not be deposited within 500 mm or other
distance described in the Contract, of concrete, cement bound materials or other
cementitious materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as SO3) exceeding 0.5 per cent
by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited
within 500 mm, or other distances described in the Contract, of metallic items
forming part of the Permanent Works.

305.2.1.4. The size of the coarse material in the mixture of earth shall ordinarily not exceed
75 mm when being placed in the embankment and 50 mm when placed in the
subgrade. However, the Engineer may at his discretion permit the use of material
coarser than this also if he is satisfied that the same will not present any difficulty
as regards the placement of fill material and its compaction to the requirements of
these Specifications. The maximum particle, size shall not be more than two-thirds
of the compacted layer thickness.

305.2.1.5. Ordinarily, only the materials satisfying the density requirements given in Table
300-1 shall be employed for the construction of the embankment and the
subgrade.

TABLE 300-1. DENSITY REQUIREMENTS OF EMBANKMENT AND SUBGRADE
MATERIALS

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Work</th>
<th>Maximum laboratory dry unit weight when tested as per IS: 2720 (Part 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Embankments up to 3 metres</td>
<td>Not less than 15.2 kN/cu.m. height, not subjected to extensive flooding.</td>
</tr>
<tr>
<td>2</td>
<td>Embankments exceeding 3 metres height or embankments of any height subject to long periods of inundation</td>
<td>Not less than 16.0 kN/cu. m.</td>
</tr>
<tr>
<td>3</td>
<td>Subgrade and earthen shoulders/verges/backfill</td>
<td>Not less than 17.5 kN/cu. m.</td>
</tr>
</tbody>
</table>

Notes: (1) Table is not applicable for lightweight fill material e.g. cinder, fly ash etc.

(2) The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

(3) The material to be used in subgrade should also satisfy design CBR at the dry unit weight applicable as per Table 300-2.

305.2.2. General requirements:
305.2.2.1. The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the subgrade and the embankment portion just below the subgrade.

305.2.2.2. Borrow materials : Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer/the Engineer, arrangement for locating the source of supply of material for embankment and subgrade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8 m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth of the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also, no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, and then he shall make good any consequent deficit of material arising therefrom.

Where the excavation reveals a combination of acceptable and unacceptable materials, the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.
The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the subgrade material when compacted to the density requirements as in Table 300-2 shall yield the design CBR value of the subgrade.

**TABLE 300-2. COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE**

<table>
<thead>
<tr>
<th>Type of work/material</th>
<th>Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Subgrade and earthen shoulders</td>
<td>Not less than 97</td>
</tr>
<tr>
<td>2 Embankment</td>
<td>Not less than 95</td>
</tr>
<tr>
<td>3 Expansive Clays</td>
<td>Not allowed</td>
</tr>
<tr>
<td></td>
<td>Not less than 90</td>
</tr>
</tbody>
</table>

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

The Dry density-moisture content -CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the subgrade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

**305.3. Construction Operations**

**305.3.1. Setting out:** After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/subgrade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/subgrade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

**305.3.2. Dewatering:** If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the
drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water. Clause 305.4.6 shall apply.

**305.3.3.** Stripping and storing topsoil: In localities where most of the available embankment materials are not conducive to plant growth, or when so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not exceeding 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily trafficked either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

**305.3.4.** Compacting ground supporting embankment/subgrade: Where necessary, the original ground shall be levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table 300-2.

In case where the difference between the subgrade level (top of the subgrade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 per cent relative compaction with respect to the dry density as given in Table 300-2, the ground shall be loosened up to a level 0.5 m below the subgrade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to not less than 97 per cent of dry density as given in Table 300-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or subgrade work shall not proceed until the foundations for embankment / subgrade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

**305.3.5.** Spreading material in layers and bringing to appropriate moisture content
305.3.5.1. The embankment and subgrade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor grader and compacted as per Clause 305.3.6. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2. Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, and rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the subgrade.

305.3.5.3. Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the
Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

305.3.6. Compaction : Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Smooth wheeled, vibratory, pneumatic tyred, sheepsfoot or pad foot rollers, etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 300-2. Subsequent layers shall be placed only after the finished layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.
When density measurements reveal any soft areas in the embankment / subgrade / earthen shoulders, further compaction shall be carried out as directed by the Engineer. If inspite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

305.3.7. Drainage: The surface of the embankment/subgrade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

305.3.8. Repairing of damages caused by rain/spillage of water: The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

305.3.9. Finishing operations: Finishing operations shall include the work of shaping and dressing the shoulders/verge/roadbed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerance described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The topsoil, removed and conserved earlier (Clause 301.3.2 and 305.3.3) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 mm to 150 mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of Clause 308.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

305.4. Construction of Embankment and Subgrade under Special Conditions
305.4.1. Earthwork for widening existing road embankment: When an existing embankment and/or subgrade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment/subgrade material to be added. The material obtained from cutting of benches could be utilized in the widening of the embankment/subgrade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of conventional rollers, compaction shall be carried out with the help of small vibratory rollers/plate compactors/power rammers or any other appropriate equipment approved by the Engineer. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other types of hauling equipment.

305.4.2. Earthwork for embankment and subgrade to be placed against sloping ground:
Where an embankment/subgrade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1 before placing the embankment/subgrade material. Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings, before the fill is placed against sloping ground.

Where the Contract requires construction of transverse subsurface drain at the cut-fill interface, work on the same shall be carried out to Clause 309 in proper sequence with the embankment and subgrade work as approved by the Engineer.

305.4.3. Earthwork over existing road surface: Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

If the existing road surface is of granular or bituminous type and lies within 1 m of the new subgrade level, the same shall be scarified to a depth of 50 mm or more if specified, so as to provide ample bond between the old and new material ensuring that at least 500 mm portion below the top of new subgrade level is compacted to the desired density.

If the existing road surface is of cement concrete type and lies within 1 m of the new subgrade level the same shall be removed completely.

If the level difference between the existing road surface and the new formation level is more than 1 m, the existing surface shall be permitted to stay in place without any modification.
305.4.4. Embankment and subgrade around structures: To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankment forming approaches to such structures, until such time as the construction of the latter is sufficiently advanced to permit the completion of approaches without the risk of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall, unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and subgrade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS: 2720 (Part 5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in Appendix 6 of IRC: 78 (Standard Specifications and Code of Practice for Road Bridges-Section VII) in respect of the type of material, the extent of backfill, its laying and compaction etc. The fill material shall be deposited in horizontal layers in loose thickness and compacted thoroughly to the requirements of Table 300-2.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2502/309.3.2 (B) unless otherwise specified in the Contract.

Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory roller, plate compactor or power rammer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

305.4.5. Construction of embankment over ground incapable of supporting construction equipment: Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geosynthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use-of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is
permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 305.3.

305.4.6. Embankment construction under water: Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall consist of graded, hard durable parades with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

305.4.7. Earthwork for high embankment: In the case of high embankments, the Contractor shall normally use the material from the specified borrow area. In case he desires to use different material for his own convenience, he shall have to carry out necessary soil investigations and redesign the high embankment at his own cost. The Contractor shall then furnish the soil test data and design of high embankment for approval of the Engineer, who reserves the right to accept or reject it.

If necessary, stage construction of fills and any controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the Contract. If settlement of surcharged fill, results in any surcharging material, which is unacceptable for use in the fill being surcharged, lying below formation level, the Contractor shall remove the unacceptable material and dispose it as per direction of the Engineer. He shall then bring the resultant level up to formation level with acceptable material.

305.4.8. Settlement period: Where settlement period is specified in the Contract, the embankment shall remain in place for (he required settlement period before excavating for abutment, wingwall, retaining wall, footings, etc., or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the Contract or as directed by the Engineer.

305.5. Plying of Traffic

Construction and other vehicular traffic shall not use the prepared surface of the embankment and/or subgrade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own expense as directed by the Engineer.

305.6. Surface Finish and Quality Control of Work
The surface finish of construction of subgrade shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7. Subgrade Strength
305.7.1. It shall be ensured prior to actual execution that the borrow area material to be used in the subgrade satisfies the requirements of design CBR.

305.7.2. Subgrade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed subgrade shall be determined on undisturbed samples cut out from the compacted subgrade in CBR mould fitted with cutting shoe or on remoulded samples, compacted to the field density at the field moisture content.

401. GRANULAR SUB-BASE
401.1. Scope
This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

401.2. Materials
401.2.1. The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 400-1.

While the gradings in Table 400-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 400-2. The grading to be adopted for a project shall be as specified in the Contract.

401.2.2. Physical requirements: The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS: 812 (Pan 111). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Pan 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions, which shall be taken as being the density relating to a uniform air, voids content of 5 per cent.
TABLE 400-1. GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Per cent by weight passing the IS sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading I</td>
</tr>
<tr>
<td>75.0 mm</td>
<td>100</td>
</tr>
<tr>
<td>53.0 mm</td>
<td>80-100</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>55-90</td>
</tr>
<tr>
<td>9.50 mm</td>
<td>35-65</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>25-55</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>20-40</td>
</tr>
<tr>
<td>0.425 mm</td>
<td>10-25</td>
</tr>
<tr>
<td>0.075 mm</td>
<td>3-10</td>
</tr>
</tbody>
</table>

| CBR Value (Minimum)  | 30 | 25 | 20 |

TABLE 400.2. GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Per cent by weight passing the IS sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading I</td>
</tr>
<tr>
<td>75.0 mm</td>
<td>100</td>
</tr>
<tr>
<td>530 mm</td>
<td>100</td>
</tr>
<tr>
<td>26.5 mm</td>
<td>55-75</td>
</tr>
<tr>
<td>9.50 mm</td>
<td></td>
</tr>
<tr>
<td>4.75 mm</td>
<td>10-30</td>
</tr>
<tr>
<td>2.36 mm</td>
<td></td>
</tr>
<tr>
<td>0.425 mm</td>
<td>&lt;10</td>
</tr>
<tr>
<td>0.075 mm</td>
<td></td>
</tr>
</tbody>
</table>

| CBR Value (Minimum)  | 30 | 25 | 20 |

Note: The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

401.3. Strength of sub-base
It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.
When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the "quality" of materials, as may be necessary.

401.4. Construction Operations

401.4.1. Preparation of subgrade: Immediately prior to the laying of sub-base, the subgrade already finished to Clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80 - 100 kN smooth wheeled roller.

401.4.2. Spreading and compacting: The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (Pan 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture content corresponding to IS: 2720 (Pan 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot-drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MN/m² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall and super-elevation and shall commence the center at the edges and progress towards for portions having crossfall on both sides.
Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

401.5. Surface Finish and Quality Control of Work
The surface finish of construction shall conform to the requirements of Clause 902.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

401.6. Arrangements for Traffic
During the period of construction, arrangement of traffic shall be maintained in accordance with Clause 112.

401.7. Measurements for Payment
Granular sub-base shall be measured as finished work in position in cubic metres.

The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

401.8. Rate
The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for:

making arrangements for traffic to Clause 112 except for initial treatment to verges, shoulders and construction of diversions;

furnishing all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;

all labour, tools, equipment and incidentals to complete the work to the Specifications;

carrying out the work in pan widths of road where directed; and

carrying out the required tests for quality control.
406. WET MIX MACADAM SUB-BASE/BASE

406.1. Scope
This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be increased to 200 mm upon approval of the Engineer.

406.2. Materials
406.2.1. Aggregates
406.2.1.1. Physical requirements: Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-10 below.

TABLE 400-10. PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB-BASE/BASE COURSES

<table>
<thead>
<tr>
<th>Test</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. * Lost Angeles Abrasion Value</td>
<td>IS : 2386 (Part-4)</td>
<td>40 Per cent (Max)</td>
</tr>
<tr>
<td>or * Aggregate Impact value</td>
<td>IS : 2386 (Part-4) or IS : 5640</td>
<td>30 Per cent (Max.)</td>
</tr>
<tr>
<td>2. Combined Flankiness and Elogation indices (Total)</td>
<td>IS : 2386 (Part-1)</td>
<td>30 Per cent (Max.)**</td>
</tr>
</tbody>
</table>

* Aggregate may satisfy requirements of either of the two tests.
** To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

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).
406.2.1.2. Grading requirements: The aggregates shall conform to the grading given in Table 400-11.

TABLE 400-11. GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Per cent by weight passing the IS sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>53.00 Mm</td>
<td>100</td>
</tr>
<tr>
<td>45.00 Mm</td>
<td>95-100</td>
</tr>
<tr>
<td>26.50 mm</td>
<td>--</td>
</tr>
<tr>
<td>22.40 mm</td>
<td>60-80</td>
</tr>
<tr>
<td>11.20 mm</td>
<td>40-60</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>25-40</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>15-30</td>
</tr>
<tr>
<td>600.00 micron</td>
<td>8-22</td>
</tr>
<tr>
<td>75.55 micron</td>
<td>0-8</td>
</tr>
</tbody>
</table>

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

406.3. Construction Operations

406.3.1. Preparation of base: Clause 404.3.1. shall apply.

406.3.2. Provision of lateral confinement of aggregates: While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 407.4.1.

406.3.3. Preparation of mix: Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.
406.3.4. Spreading of mix: Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:

Loading hoppers and suitable distribution mechanism

The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rotting or otherwise marring the surface profile.

The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

406.3.5. Compaction: After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.
Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8)

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

406.3.6. Setting and drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

406.4. Opening to Traffic

Preferably no vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

406.5. Surface Finish and Quality Control of Work

406.5.1. Surface evenness : The surface finish of construction shall conform to the requirements of Clause 902.

406.5.2. Quality control : Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

406.6. Rectification of Surface Irregularity Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to subgrade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompacted in accordance with Clause 406.3. The area treated
in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

406.7. Arrangement for Traffic
During the period of construction, arrangement of traffic shall be done as per Clause 112.

406.8. Measurements for Payment
Wet mix macadam shall be measured as finished work in position in cubic metres.

406.9. Rates
The Contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8.

CONSTRUCTION OF BITUMINOUS ROADS

502. PRIME COAT OVER GRANULAR BASE
502.1. Scope
This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

502.2. Materials

502.2.1. Primer: The choice of a bituminous primer shall depend upon the porosity characteristics of the surface to be primed as classified in IRC: 16. These are:

Surface of low porosity; such as wet mix macadam and water bound macadam,

Surfaces of medium porosity; such as cement stabilized soil base,

Surfaces of high porosity; such as a gravel base.

502.2.2. Primer viscosity: The type and viscosity of the primer shall comply with the requirements of IS 8887, as sampled and tested for bituminous primer in accordance with these standards. Guidance on viscosity and rate of spray is given in Table 500-1.

| TABLE 500-1. VISCOSITY REQUIREMENT AND QUANTITY OF LIQUID BITUMINOUS PRIMER |
|---------------------------------|---------------------------------|---------------------------------|
| Type of surface                 | Kinematic Viscosity of Primer at 60°C (Centistokes) | Quantity of Liquid Bituminous Material per 10 Sq.m. (kg) |
| Low porosity                    | 30-60                                          | 6 to 9                          |
| Medium porosity                 | 70-140                                         | 9 to 12                          |
High porosity 250-500 12 to 15

502.2.3. Choice of primer: The primer shall be bitumen emulsion, complying with IS 8887 of a type and grade as specified in the Contract or as directed by the Engineer. The use of medium curing cutback as per IS 217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer.

502.3. Weather and Seasonal Limitations
Bituminous primer shall not be applied to a wet surface (see 502.4.2) or during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Surfaces which are 155 to receive emulsion primer should be damp, but no free or standing water shall be present.

502.4. Construction
502.4.1. Equipment: The primer distributor shall be a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying of small areas, inaccessible to the distributor, or in narrow strips shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

502.4.2. Preparation of road surface: The surface to be primed shall be prepared in accordance with Clauses 501.8. and 902 as appropriate. Immediately prior to applying the primer the surface shall be carefully swept clean of dust and loose particles, care being taken not to disturb the interlocked aggregate. This is best achieved when the surface layer is slightly moist (lightly sprayed with water and the surface allowed to dry) and the surface should be kept moist until the primer is applied.

502.4.3. Application of bituminous primer: The viscosity and rate of application of the primer shall be as specified in the Contract, or as determined by site trials carried out as directed by the Engineer. Where a geosynthetic is proposed for use, the requirements of Clauses 703.3.2 and 703.4 shall apply. The bituminous primer shall be sprayed uniformly in accordance with Clause 501. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

502.4.4. Curing of primer and opening to traffic: A primed surface shall be allowed to cure for at least 24 hours or such other period as is found to be necessary to allow all the volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with an application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course. A very thin layer of clean sand may be applied to the surface of the primer, to prevent the primer picking up under the wheels of the paver and the trucks delivering bituminous material to the paver.

502.4.5. Tack coat: Over the primed surface, a tack coat should be applied in accordance with Clause 503.
502.5. Quality Control of Work
For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

502.6. Arrangements for Traffic
During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

502.7. Measurement for Payment
Prime coat shall be measured in terms of surface area of application in square metres.

502.8. Rate
The contract unit rate for prime coat with adjustments as described in Clause 502.7 shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of 0.6 kg per square metre, with adjustment, plus or minus, for the variation between this amount and the actual amount approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.

507. DENSE GRADED BITUMINOUS MACADAM

507.1. Scope
This clause specifies the construction of Dense Graded Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. DBM is also intended for use as road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50mm to 100mm.

507.2. Materials
507.2.1. Bitumen: The bitumen shall be paving bitumen of Penetration Grade complying with Indian Standard Specifications for “Paving Bitumen” IS: 73, and of the penetration indicated in Table 500-10 for dense bitumen macadam, or this bitumen as modified by one of the methods specified in Clause 521, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

507.2.2. Coarse aggregates: The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor’s selected source of aggregates have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer’s recommendations, without additional payment. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the physical requirements specified in Table 500-8, for dense bituminous macadam.
Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

507.2.3. Fine aggregates: Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36mm sieve and retained on the 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter.

The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS: 2720 (Part 37).

The plasticity index of the fraction passing the 0.425 nun sieve shall not exceed 4. When tested in accordance with IS: 2720 (Part 5)

TABLE 500-8. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR DENSE GRADED BITUMINOUS MACADAM

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness</td>
<td>Grain size analysis1</td>
<td>Max 5% passing 0.075mm</td>
</tr>
<tr>
<td></td>
<td>Flakiness and Elongation Index (Combined) 2</td>
<td>Max 30%</td>
</tr>
<tr>
<td>Particle shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength*</td>
<td>Los Angeles Abrasion Value3</td>
<td>Max 35%</td>
</tr>
<tr>
<td></td>
<td>Aggregate Impact Value4</td>
<td>Max 27%</td>
</tr>
<tr>
<td>Durability</td>
<td>Soundness:5</td>
<td>Max 12% Max 18%</td>
</tr>
<tr>
<td></td>
<td>Sodium Sulphate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Magnesium Sulphate</td>
<td></td>
</tr>
<tr>
<td>Water Stripping</td>
<td>Water absorption6</td>
<td>Max 2%</td>
</tr>
<tr>
<td></td>
<td>Coating and Stripping of Bitumen</td>
<td>Minimum retained coating 95%</td>
</tr>
<tr>
<td></td>
<td>Aggregate Mixtures7</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Retained Tensile Strength8</td>
<td>Min 80%</td>
</tr>
</tbody>
</table>

Notes: 1. IS: 2386 Part 1  5. IS: 2386 Part 5
2. IS: 2386 Part 1  6. IS: 2386 Part 3 (the elongation test to be done only on non-flaky aggregates in the sample)
3. IS:2386 Part 4*  7. IS: 6241
4. IS: 2386 Part 4*  8. AASHTO T283**

* Aggregate may satisfy requirements of either of these two tests.

** The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.
507.2.4. Filler: Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer.

The filler shall be graded within the limits indicated in Table 500-9.

**TABLE 500-9. GRADING REQUIREMENTS FOR MINERAL FILLER**

<table>
<thead>
<tr>
<th>IS Sieve (mm)</th>
<th>Cumulative per cent passing by weight of total aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>100</td>
</tr>
<tr>
<td>0.3</td>
<td>95 - 100</td>
</tr>
<tr>
<td>0.075</td>
<td>85 – 100</td>
</tr>
</tbody>
</table>

The filler shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. When the coarse aggregate is gravel, 2 per cent by weight of total aggregate, shall be Portland cement or hydrated lime and the percentage of fine aggregate reduced accordingly. Cement or hydrated lime is not required when the limestone aggregate is used. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

507.2.5. Aggregate grading and binder content: When tested in accordance with IS: 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 500-10, for dense bituminous macadam grading 1 or 2 as specified in the Contract. The type and quantity of bitumen, and appropriate thickness, are also indicated for each mixture type.

**TABLE 500-10. COMPOSITION OF DENSE GRADED BITUMINOUS MACADAM PAVEMENT LAYERS**

<table>
<thead>
<tr>
<th>Grading</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal aggregate size</td>
<td>40mm</td>
<td>25 mm</td>
</tr>
<tr>
<td>Layer Thickness</td>
<td>80-100 mm</td>
<td>50-75 mm</td>
</tr>
<tr>
<td>IS Sieve1 (mm)</td>
<td>Cumulative % by weight of total aggregate</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>37.5</td>
<td>95 – 100</td>
<td>90 - 100</td>
</tr>
<tr>
<td>26.5</td>
<td>63 – 93</td>
<td>71 - 95</td>
</tr>
<tr>
<td>19</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13.2</td>
<td>55 – 75</td>
<td>56 - 80</td>
</tr>
<tr>
<td>9.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4.75</td>
<td>38 – 54</td>
<td>38 - 54</td>
</tr>
<tr>
<td>2.36</td>
<td>28 – 42</td>
<td>28 - 42</td>
</tr>
<tr>
<td>1.18</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.3</td>
<td>7 – 21</td>
<td>7 - 21</td>
</tr>
<tr>
<td>0.15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.075</td>
<td>2 – 8</td>
<td>2 - 8</td>
</tr>
<tr>
<td>Bitumen content % by mass of total mix2</td>
<td>Min 4.0</td>
<td>Min 4.5</td>
</tr>
</tbody>
</table>
Special Conditions of Contract
Engineering Projects (India) Limited

Bitumen grade (pen) | 65 or 90 | 65 or 90

Notes:
1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
2. Determined by the Marshall method.

507.3. Mixture Design

507.3.1. Requirement for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-11.

TABLE 500-11. REQUIREMENTS FOR DENSE GRADED BITUMINOUS MACADAM

<table>
<thead>
<tr>
<th>Requirement</th>
<th>9.0</th>
<th>2</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum stability (kN at 60 oC)</td>
<td>3-6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum flow (mm)</td>
<td>75 blows on each of the two faces of the specimen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum flow (mm)</td>
<td>See Table 500-12 below</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compaction level (Number of blows)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per cent air voids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per cent voids in mineral aggregate (VMA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per cent voids filled with bitumen</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12.

TABLE 500-12. MINIMUM PER CENT VOIDS IN MINERAL AGGREGATE (VMA)

<table>
<thead>
<tr>
<th>Nominal Particle Size</th>
<th>Minimum VMA, Per cent Related to Design Air Voids, Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mm)</td>
<td>3.0</td>
</tr>
<tr>
<td>9.5</td>
<td>14.0</td>
</tr>
<tr>
<td>12.5</td>
<td>13.0</td>
</tr>
<tr>
<td>19.0</td>
<td>12.0</td>
</tr>
<tr>
<td>25.0</td>
<td>11.0</td>
</tr>
<tr>
<td>37.5</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Notes:
1. The nominal maximum particle size is one size larger than the first sieve to retain more than 10 per cent.
2. Interpolate minimum voids in the mineral aggregate (VMA) for design air voids values between those listed.
507.3.2. Binder content: The binder content shall be optimised to achieve the requirements of the mixture set out in Table 500-11 and the traffic volume specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in The Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve by the aggregates passing the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

Where 40 mm dense bituminous macadam mixture is specified, the modified Marshall method described in MS-2 shall be used. This method requires modified equipment and procedures; particularly the minimum stability values in Table 500-11 be multiplied by 2.25, and the minimum flow shall be 3 mm.

507.3.3. Job mix formula: The Contractor shall inform the Engineer in writing, at least 20 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the following details:

Source and location of all materials;

Proportions of all materials expressed as follows where each is applicable:

Binder type, and percentage by weight of total mixture;

Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;

A single definite percentage passing each sieve for the mixed aggregate;

The individual grading of the individual aggregate fractions, and the proportion of each in the combined grading.

The results of tests enumerated in Table 500-11 as obtained by the Contractor;

Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch,

Test results of physical characteristics of aggregates to be used;

Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mixture and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.
The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded to the Engineer for approval before the placing of the material.

507.3.4. Plant trials - permissible variation in job mix formula: Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500-13. These variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900.

<table>
<thead>
<tr>
<th>Description</th>
<th>Permissible Variations Base/binder course</th>
<th>Wearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate passing 19mm sieve or larger</td>
<td>± 8%</td>
<td>± 7%</td>
</tr>
<tr>
<td>Aggregate passing 13.2mm, 9.5mm</td>
<td>± 7%</td>
<td>± 6%</td>
</tr>
<tr>
<td>Aggregate passing 4.75mm</td>
<td>± 6%</td>
<td>± 5%</td>
</tr>
<tr>
<td>Aggregate passing 2.36mm, 1.18mm</td>
<td>± 5%</td>
<td>± 4%</td>
</tr>
<tr>
<td>Aggregate passing 0.3mm, 0.15mm</td>
<td>± 4%</td>
<td>± 3%</td>
</tr>
<tr>
<td>Aggregate passing 0.075mm</td>
<td>± 2%</td>
<td>± 1.5%</td>
</tr>
<tr>
<td>Binder content</td>
<td>± 0.3%</td>
<td>± 0.3%</td>
</tr>
<tr>
<td>Mixing temperature</td>
<td>± 10°C</td>
<td>± 10°C</td>
</tr>
</tbody>
</table>

Once the plant trials have demonstrated the capability of the plant, and the trials are approved, the laying operation may commence. Over the period of the first month of production for laying on the works, the Engineer shall require additional testing of the product to establish the reliability and consistency of the plant.

507.3.5. Laying Trials: Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid, and compacted all in accordance with Clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works, unless specifically approved in writing, by the Engineer. The area of the laying trials shall be a minimum of 100 sq.m. of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method.
Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

507.4. Construction Operations

507.4.1. Weather and seasonal limitations: The provisions of Clause 501.5.1 shall apply.

507.4.2. Preparation of base: The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air. In locations where mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

507.4.3. Geosynthetics: Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in Clause 703.

507.4.4. Stress absorbing layer: Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 522.

507.4.5. Prime coat: Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502, or as directed by the Engineer.

507.4.6. Tack coat: Where the material on which the dense bituminous macadam is to be placed is a bitumen bound surface, a tack coat shall be applied as specified, in accordance with the provisions of Clause 503, or as directed by the Engineer.

507.4.7. Mixing and transportation of the mixture: The provisions as specified in Clauses 501.3 and 501.4 shall apply.

507.4.8. Spreading: The provisions of Clauses 501.5.3 and 501.5.4. shall apply.

507.4.9. Rolling: The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

507.5. Opening to Traffic
The newly laid surface shall not be open to traffic for at least 24 hrs after laying and completion of compaction, without the express approval of the Engineer in writing.

507.6. Surface Finish and Quality Control of Work
The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of this Specification.
507.7. Arrangements for Traffic
During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

507.8. Measurement for Payment
Dense Graded Bituminous Materials shall be measured as finished work either in cubic metres, tons or by the square metre at a specified thickness as detailed on the Contract drawings, or documents, or as directed by the Engineer.

507.9. Rate
The contract unit rate for Dense Graded Bituminous Macadam shall be payment in full for carrying out the all required operations as specified, and shall include, but not necessarily limited to all components listed in Clause 501.8.8.2 (i) to (xi). The rate shall include the provision of bitumen, at 4.25 per cent by weight of the total mixture.

The variance in actual percentage of bitumen used will be assessed and the payment adjusted, up or down, accordingly.

508. SEMI-DENSE BITUMINOUS CONCRETE

508.1. Scope
This clause specifies the construction of Semi Dense Bituminous Concrete, for use in wearing/binder and profile corrective courses. This work shall consist of construction in a single or multiple layers of semi dense bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25mm to 100mm in thickness.

508.2. Materials
508.2.1. Bitumen: The bitumen shall be paving bitumen of Penetration grade complying with Indian Standard Specification for Paving Bitumen, IS: 73 and of the penetration indicated in Table 500-15, for semi dense bituminous concrete, or this bitumen as modified by one of the methods specified in Clause 521, or as otherwise specified in the Contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

508.2.2. Coarse aggregates: The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-14.

508.2.3. Fine aggregates: The fine aggregates shall be all as specified in Clause 507.2.3.

508.2.4. Filler: Filler shall be generally as specified in Clause 507.2.4. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-14 then 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.

508.2.5. Aggregate grading and binder content: When tested in accordance with IS:2386 Part 1 (Wet sieving method), the combined grading of the coarse and fine aggregates and added
filler shall fall within the limits shown in Table 500-15 for gradings 1 or 2 as specified in the Contract.

508.3. Mixture Design

508.3.1. Requirements for the mixture: Apart from conformity with the grading and quality requirements for individual ingredients the mixture shall meet the requirements set out in Table 500-16.

TABLE 500-14. PHYSICAL REQUIREMENTS FOR COARSE AGGREGATE FOR SEMI DENSE BITUMINOUS CONCRETE PAVEMENT LAYERS

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness (dust)</td>
<td>Grain size analysis1</td>
<td>Max 5% passing 0.075mm sieve</td>
</tr>
<tr>
<td>Particle shape</td>
<td>Flakiness and Elongation Index (Combined)2</td>
<td>Max 30%</td>
</tr>
<tr>
<td>Strength*</td>
<td>Los Angeles Abrasion Value3</td>
<td>Max 35%</td>
</tr>
<tr>
<td></td>
<td>Aggregate Impact Value4</td>
<td>Max 27%</td>
</tr>
<tr>
<td>Polishing</td>
<td>Polished Stone Value5</td>
<td>Min 55</td>
</tr>
<tr>
<td>Durability</td>
<td>Soundness :6</td>
<td>Max 12%</td>
</tr>
<tr>
<td></td>
<td>Sodium Sulphate</td>
<td>Max 2%</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>Water absorption7</td>
<td>Max 2%</td>
</tr>
<tr>
<td>Stripping</td>
<td>Coating and Stripping of Bitumen Aggregate Mixtures9</td>
<td>Minimum Retained Coating 95 %</td>
</tr>
<tr>
<td>Water Sensitivity**</td>
<td>Retained Tensile Strength8</td>
<td>Min 80 %</td>
</tr>
</tbody>
</table>

2. IS: 2386 Part 1  7. IS: 2386 Part 3
3. IS: 2386 Part 4*  8. AASHTOT283**
5. BS: 812 Part 114

* Aggregate may satisfy requirements of either of these two tests.

** The water sensitivity test is only required if the minimum retained coating in the stripping test is less than 95%.
The requirements for minimum per cent voids in mineral aggregate (VMA) are set out in Table 500-12.

508.3.2. Binder content: The binder content shall be optimised to achieve the requirements of the mixture set out in Table 500-16 and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5mm sieve and retained on the 22.4mm sieve, where approved by the Engineer.

### TABLE 500-15. COMPOSITION OF SEMI DENSE BITUMINOUS CONCRETE PAVEMENT LAYERS

<table>
<thead>
<tr>
<th>Grading</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal aggregate size</td>
<td>13 mm</td>
<td>10 mm</td>
</tr>
<tr>
<td>Layer Thickness</td>
<td>35-40 mm</td>
<td>25-30 mm</td>
</tr>
<tr>
<td>IS Sieve1 (mm)</td>
<td>Cumulative % by weight of total aggregate passing</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>37.5</td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>26.5</td>
<td>70-90</td>
<td>90-100</td>
</tr>
<tr>
<td>19</td>
<td>35-51</td>
<td>35-51</td>
</tr>
<tr>
<td>13.2</td>
<td>24-39</td>
<td>24-39</td>
</tr>
<tr>
<td>9.5</td>
<td>15-30</td>
<td>15-30</td>
</tr>
<tr>
<td>4.75</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2.36</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1.18</td>
<td>9-19</td>
<td>9-19</td>
</tr>
<tr>
<td>0.6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.3</td>
<td>3-8</td>
<td>3-8</td>
</tr>
<tr>
<td>0.15</td>
<td>Min 4.5</td>
<td>Min 5.0</td>
</tr>
<tr>
<td>0.075</td>
<td>Bitumen content % by mass of total mix</td>
<td></td>
</tr>
<tr>
<td>Bitumen grade (pen)</td>
<td>65*</td>
<td>65*</td>
</tr>
</tbody>
</table>

Notes:
1. The combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.
2. Determined by the Marshall method.
* Only in exceptional circumstances, 80/100 penetration grade may be used, as approved by the Engineer.

### TABLE 500-16. REQUIREMENTS FOR SEMI DENSE BITUMINOUS PAVEMENT LAYERS

<p>| Minimum stability (kN at 60 oC) | 8.2 |</p>
<table>
<thead>
<tr>
<th>Minimum flow (mm)</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum flow (mm)</td>
<td>4</td>
</tr>
<tr>
<td>Compaction level (Number of blows)</td>
<td>75 blows on each of the two faces of the specimen</td>
</tr>
<tr>
<td>Per cent air voids</td>
<td>3-5</td>
</tr>
<tr>
<td>Per cent voids in mineral aggregate (VMA)</td>
<td>See Table 500-12 below</td>
</tr>
<tr>
<td>Per cent voids filled with bitumen</td>
<td>65-78</td>
</tr>
</tbody>
</table>

508.3.3. Job mix formula: The procedure for formulating the job mix formula shall be generally as specified in Clause 507.3.3 and the results of tests enumerated in Table 500-16 as obtained by the Contractors.

508.3.4. Plant trials - permissible variation in job mix formula: The requirements for plant trials shall be all as specified in Clause 507.3.4, and permissible limits for variation as shown in Table 500-13.

508.3.5. Laying trials: The requirements for laying trials shall be all as specified in Clause 507.3.5.

508.4. Construction Operations

508.4.1. Weather and seasonal limitations: The provisions of Clause 501.5.1 shall apply.

508.4.2. Preparation of base: The surface on which the Semi Dense Bituminous material is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the Engineer.

508.4.3. Geosynthetics: Where Geosynthetics are specified in the Contract this shall be in accordance with the requirements stated in Clause 703

508 4.4. Stress absorbing layer: Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 522.

508.4.5. Tack coat: Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of Clause 503.

508.4.6. Mixing and transportation of the mixture: The provisions as specified in Clauses 501.3 and 501.4 shall apply.

508.4.7. Spreading: The general provisions of Clauses 501.5.3 and 501.5.4 shall apply.
508.4.8. Rolling: The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

508.5. Opening to Traffic
The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the Engineer in writing.

508.6. Surface Finish and Quality Control
The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of this Specification.

508.7. Arrangements for Traffic
During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

508.8. Measurement for Payment
The measurement shall be all as specified in Clause 507.8.

508.9. Rate
The contract unit rate shall be all as specified in Clause 507.9, except that the rate shall include the provision of bitumen at 4.75 per cent, by weight of total mixture. The variance in actual percentage of bitumen used will be assessed and the payment adjusted up or down, accordingly.

601. DRY LEAN CEMENT CONCRETE SUB-BASE

601.1. Scope
601.1.1. The work shall consist of construction of dry lean concrete subbase for cement concrete pavement in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations, in connection with the work, as approved by the Engineer.

601.1.2. The design parameters of dry lean concrete sub-base, viz., width, thickness, grade of concrete, details of joints, if any, etc. shall be as stipulated in the Contract drawings.

601.2. Materials

601.2.1. Source of Materials: The Contractor shall indicate to the Engineer the source of all materials with relevant test data to be used in the lean concrete work sufficiently in advance and the approval of the Engineer for the same shall be obtained at least 45 days before the
scheduled commencement of the work. If the Contractor later proposes to obtain the materials from a different source, he shall notify the Engineer for his approval at least 45 days before such materials are to be used.

601.2.2. Cement: Any of the following types of cement may be used with prior approval of the Engineer:

- Ordinary Portland Cement
- Portland Slag Cement
- Portland Pozzolana Cement

If the subgrade is found to consist of soluble sulphates in a concentration more than 0.5 per cent, cement used shall be sulphate resistant and shall conform to IS: 6909.

Cement to be used may preferably be obtained in bulk form. It shall be stored in accordance with stipulations contained in Clause 1014 and shall be subjected to acceptance test prior to its immediate use.

601.2.3. Aggregates:

601.2.3.1. Aggregates for lean concrete shall be natural material complying with IS: 383. The aggregates shall not be alkali reactive. The limits of deleterious materials shall not exceed the requirements set out in IS: 383. In case the Engineer considers that the aggregates are not free from din, the same may be washed and drained for at least 72 hours before batching, as directed by the Engineer.

601.2.3.2. Coarse aggregate: Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of the coarse aggregate shall be 25 mm. The coarse aggregate shall comply with Clause 602.2.4.2.

601.2.3.3. Fine aggregate: The fine aggregate shall consist of clean, natural sand or crushed stone sand or a combination of the two and shall conform to IS: 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica, organic and other foreign matter. The fine aggregate shall comply with Clause 602.2.4.3.

601.2.3.4. The coarse and fine aggregates may be obtained in either of the following manner:

In separate nominal sizes of coarse and fine aggregates and mixed together intimately before use.
Separately as 25 mm nominal single size, 12.5 mm nominal size graded aggregates and fine aggregate of crushed stone dust or sand or a combination of these two.

The material after blending shall conform to the grading as indicated in Table 600-1.

TABLE 600-1. AGGREGATE GRADATION FOR DRY LEAN CONCRETE
601.2.4. Water: Water used for mixing and curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

601.2.5. Storage of materials: All materials shall be stored in accordance with the provisions of Clause 1014 of these Specifications and other relevant IS Specifications. All efforts must be made to store the materials in proper places so as to prevent their deterioration or contamination by foreign matter and to ensure their satisfactory quality and fitness for use in the work. The storage place must also permit easy inspection, removal and storage of materials. All such materials even though stored in approved godowns must be subjected to acceptance test immediately prior to their use. The requirement of storage yard specified in Clause 602.2.9 shall also be applicable.

601.3. Proportioning of Materials for the Mix

601.3.1. The mix shall be proportioned with a maximum aggregate cement ratio of 15:1. The water content shall be adjusted to the optimum as per Clause 601.3.2 for facilitating compaction by rolling. The strength and density requirements of concrete shall be determined in accordance with Clause 601.6 by making trial mixes.

601.3.2. Moisture content: The right amount of water for the lean concrete in the main work shall be decided so as to ensure full compaction under rolling and shall be assessed at the time of rolling the trial length. Too much water will cause the lean concrete to be heaving up before the wheels and picked up on the wheels of the roller and too little will lead to inadequate compaction, a low in-situ strength and an open-textured surface.

The optimum water content shall be determined and demonstrated by rolling during trial length construction and the optimum moisture content and degree of compaction shall be got approved from the Engineer. While laying in the main work, the lean concrete shall have a moisture content between the optimum and optimum +2 per cent, keeping in view the effectiveness of compaction achieved and to compensate for evaporation losses.

601.3.3. Cement content: The minimum cement content in the lean concrete shall not be less than 150 kg/cu.m. of concrete. If this minimum cement content is not sufficient to produce concrete of the specified strength, it shall be increased as necessary without additional cost compensation to the Contractor.

<table>
<thead>
<tr>
<th>Sieve Designation</th>
<th>Percentage passing the sieve by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.50 mm</td>
<td>100</td>
</tr>
<tr>
<td>19.00 mm</td>
<td>80-100</td>
</tr>
<tr>
<td>9.50 mm</td>
<td>55-75</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>35-60</td>
</tr>
<tr>
<td>600.00 micron</td>
<td>10-35</td>
</tr>
<tr>
<td>75.00 micron</td>
<td>0-8</td>
</tr>
</tbody>
</table>
601.3.4. Concrete strength: The average compressive strength of each consecutive group of 5 cubes made in accordance with Clause 903.5.1.1 shall not be less than 10 MPa at 7 days. In addition, the minimum compressive strength of any individual cube shall not be less than 7.5 MPa at 7 days. The design mix complying with the above Clauses shall be got approved from the Engineer and demonstrated in the trial length construction.

601.4. Subgrade
The subgrade shall conform to the grades and cross sections shown on the drawings and shall be uniformly compacted to the design strength in accordance with these Specifications and Specification stipulated in the Contract. The lean concrete subbase shall not be laid on a subgrade softened by rain after its final preparation; surface trenches and soft spots, if any, must be properly back-filled and compacted to avoid any weak or soft spot. As far as possible, the construction traffic shall be avoided on the prepared subgrade. A day before placing of the sub-base, the subgrade surface shall be given a fine spray of water and rolled with one or two passes of a smooth wheeled roller after a lapse of 2-3 hours in order to stabilise loose surface. If Engineer feels it necessary, another fine spray of water may be applied just before placing sub-base.

601.5. Construction

601.5.1. General: The pace and programme of the lean concrete sub-base construction shall be matching suitably with the programme of construction of the cement concrete pavement over it. The sub-base shall be overlaid with cement concrete pavement only after 7 days after sub-base construction.

601.5.2. Batching and mixing: The batching plant shall be capable of proportioning the materials by weight, each type of material being weighed separately in accordance with Clause 602.9.3.2. The cement from the bulk stock shall be weighed separately from the aggregates. The capacity of batching and mixing plant shall be at least 25 per cent higher than the proposed capacity for the laying arrangements. The batching and mixing shall be carried out preferably in a forced action central batching and mixing plant having necessary automatic controls to ensure accurate proportioning and mixing. Other types of mixers shall be permitted subject to demonstration of their satisfactory performance during the trial length. The type and capacity of the plant shall be got approved by the Engineer before commencement of the trial length. The weighing balances shall be calibrated by weighing the aggregates, cement, water and admixtures physically either by weighing with large weighing machine or in a weigh bridge. The accuracy of weighing scales of the batching plant shall be within ± 2 per cent in the case of aggregates and ±1 percent in the case of cement and water.

The design features of Batching Plant should be such that the shifting operations of the plant will not take very long time when they are to be shifted from place to place with the progress of the work.

601.5.3. Transporting: Plant mix lean concrete shall be discharged immediately from the mixer, transported directly to the point where it is to be laid and protected from the weather by covering the tippers/ dumpers with tarpaulin during transit. The concrete shall be transported by tipping trucks, sufficient in number to ensure a continuous supply of material to feed the
laying equipment to work at a uniform speed and in an uninterrupted manner. The lead of the batching plant to paving site shall be such that the travel time available from mixing to paving as specified in Clause 601.5.5.2 will be adhered to.

601.5.4. Placing: Lean concrete shall be laid/placed by a paver with electronic sensor. The equipment shall be capable of laying the material in one layer in an even manner without segregation, so that after compaction the total thickness is as specified. The paving machine shall have high amplitude tamping bars to give good initial compaction to the sub-base.

The laying of the two-lane road subbase may be done either in full width or lane by lane. Preferably the lean concrete shall be placed and compacted across the full width of the road, by constructing it in one go or in two lanes running forward simultaneously. Transverse and longitudinal construction joints shall be staggered by 500-1000 mm and 200-400 mm respectively from the corresponding joints in the overlaying concrete slabs.

601.5.5. Compaction

601.5.5.1. The compaction shall be carried out immediately after the material is laid and levelled. In order to ensure thorough compaction, which is essential, rolling shall be continued on the full width till there is no further visible movement under the roller and the surface is closed. The minimum dry density obtained shall be 97 per cent of that achieved during the trial length construction vide Clause 601.7. The densities achieved at the edges i.e 0.5 m from the edge shall not be less than 95 per cent of that achieved during the trial construction vide Clause 601.7.

601.5.5.2. The spreading, compacting and finishing of the lean concrete shall be carried out as rapidly as possible and the operation shall be so arranged as to ensure that the time between the mixing of the first batch of concrete in any transverse section of the layer and the final finishing of the same shall not exceed 90 minutes when the concrete temperature is above 25 and below 30 degree Celsius and 120 minutes if less than 25 degree Celsius. This period may be reviewed by the Engineer in the light of the results of the trial run but in no case shall it exceed 2 hours. Work shall not proceed when the temperature of the concrete exceeds 30 degree Celsius. If necessary, chilled water or addition of ice may be rescued to for bringing down the temperature. It is desirable to stop concreting when the ambient temperature is above 35°C. After compaction has been completed, roller shall not stand on the compacted surface for the duration of the curing period except during commencement of next day's work near the location where work was terminated the previous day.

601.5.5.3. Double drum smooth-wheeled vibratory rollers of minimum 80 to 100 kN static weight are considered to be suitable for rolling dry lean concrete. In case any other roller is proposed, the same shall be got approved from the Engineer, after demonstrating its performance. The number of passes required to obtain maximum compaction depends on the thickness of the lean concrete, the compactibility of the mix, and the weight and type of the roller etc., and the same as well as the total requirement of rollers for the job shall be determined during trial run by measuring the in-situ density and the scale of the work to be undertaken.
601.5.5.4. In addition to the number of passes required for compaction there shall be a preliminary pass without vibration to bed the lean concrete down and again a final pass without vibration to remove roller marks and to smoothen the surface.

Special care and attention shall be exercised during compaction near joints, kerbs, channels, side forms and around gullies and manholes. In case adequate compaction is not achieved by the roller at these points, use of plate vibrator shall be made, if so directed by the Engineer.

601.5.5.5. The final lean concrete surface on completion of compaction and immediately before overlaying, shall be well closed, free from movement under roller and free from ridges, low spots, cracks, loose material, pot holes, ruts or other defects. The final surface shall be inspected immediately on completion and all loose, segregated or defective areas shall be corrected by using fresh lean concrete material laid and compacted as per Specification. For repairing honeycombed surface, concrete with aggregates of size 10 mm and below shall be spread and compacted. It is necessary to check the level of the rolled surface for compliance. Any level/thickness deficiency should be corrected after applying concrete with aggregates of size 10 mm and below after roughening the surface. Similarly the surface regularity also should be checked with 3m straight edge. The deficiency should be made up with concrete with aggregates of size 10 mm and below.

601.5.5.6. Segregation of concrete in the dumplers shall be controlled by premixing each fraction of the aggregates before loading in the bin of the batching plant, by moving the dumper back and forth while discharging the mix on it and other means. Even paving operation shall be such that the mix does not segregate.

601.5.6. Joints: Contraction and longitudinal joints shall be provided as per the drawing.

At longitudinal or transverse construction joints, unless vertical forms are used, the edge of compacted material shall be cut back to a vertical face where the correct thickness of the properly compacted material has been obtained.

601.5.7. Curing; As soon as the lean concrete surface is compacted, curing shall commence. One of the following two methods shall be adopted:

The initial curing shall be done by spraying with liquid curing compound. The curing compound shall be white pigmented or transparent type with water retention index of 90 per cent when tested in accordance with BS 7542. Curing compound shall be sprayed immediately after rolling is complete. As soon as the curing compound has lost its tackiness, the surface shall be covered with wet hessian for three days.

Curing shall be done by covering the surface by gunny bags/hessian, which shall be kept continuously moist for 7 days by sprinkling water.

602. CEMENT CONCRETE PAVEMENT

602.1. Scope

602.1.1. The work shall consist of construction of unreinforced, dowel jointed, plain cement concrete pavement in accordance with the requirements of these Specifications and in
conformity with the lines, grades and cross sections shown on the drawings. The work shall include furnishing of all plant and equipment, materials and labour and performing all operations in connection with the work, as approved by the Engineer.

602.1.2. The design parameters, viz., thickness of pavement slab, grade of concrete, joint details etc. shall be as stipulated in the drawings.

602.2. Materials

602.2.1. Source of materials: The Contractor shall indicate to the Engineer the source of all materials to be used in the concrete work with relevant test data sufficiently in advance, and the approval of the Engineer for the same shall be obtained at least 45 days before the scheduled commencement of the work. If the Contractor later proposes to obtain materials from a different source, he shall notify the Engineer for his approval, at least 45 days before such materials are to be used with relevant test data.

602.2.2. Cement : Any of the following types of cement capable of achieving the design strength may be used with prior approval of the Engineer, but the preference should be to use at least the 43 Grade or higher.

Ordinary Portland Cement, 33 Grade, IS: 269.

Ordinary Portland Cement, 43 Grade IS: 8112.

Ordinary Portland Cement, 53 Grade, IS: 12269.

If the soil around has soluble salts like sulphates in excess of 0.5 per cent, the cement used shall be sulphate resistant and shall conform to IS: 12330.

Guidance may be taken from IS: SP: 23, Handbook for Concrete Mixes for ascertaining the minimum 7 days strength of cement required to match with the design concrete strength. Cement to be used may preferably be obtained in bulk form. If cement in paper bags are proposed to be used, there shall be bag-splitters with the facility to separate pieces of paper bags and dispose them suitably. No paper pieces shall enter the concrete mix. Bulk cement shall be stored in accordance with Clause 1014. The cement shall be subjected to acceptance test just prior to its use.

602.2.3. Admixtures : Admixtures conforming to IS:6925 and IS: 9103 shall be permitted to improve workability of the concrete or extension of setting time, on satisfactory evidence that they will not have any adverse effect on the properties of concrete with respect to strength, volume change, durability and have no deleterious effect on steel bars. The particulars of the admixture and the quantity to be used must be furnished to the Engineer in advance to obtain his approval before use. Satisfactory performance of the admixtures should be proved both on the laboratory concrete trial mixes and in trial paving works. If air-entraining admixture is used, the total quantity of air in air-entrained concrete as a percentage of the volume of the mix shall be 5 ± 1.5 per cent for 25 mm nominal size aggregate.
602.2.4. Aggregates

602.2.4.1. Aggregates for pavement concrete shall be natural material complying with IS: 383 but with a Los Angeles Abrasion Test result not more than 35 per cent. The limits of deleterious materials shall not exceed the requirements set out in IS: 383.

The aggregates shall be free from chert, flint, chalcedony or other silica in a form that can react with the alkalies in the cement. In addition, the total chlorides content expressed as chloride ion content shall not exceed 0.06 per cent by weight and the total sulphate content expressed as sulphuric anhydride (SO₄) shall not exceed 0.25 per cent by weight.

602.2.4.2. Coarse aggregate: Coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone or crushed gravel and shall be devoid of pieces of disintegrated stone, soft, flaky, elongated, very angular or splintery pieces. The maximum size of coarse aggregate shall not exceed 25 mm for pavement concrete. Continuously graded or gap graded aggregates may be used, depending on the grading of the fine aggregate. No aggregate which has water absorption more than 2 per cent shall be used in the concrete mix. The aggregates shall be tested for soundness in accordance with IS: 2386 (Part-5). After 5 cycles of testing the loss shall not be more than 12 per cent if sodium sulphate solution is used or 18 per cent if magnesium sulphate solution is used.

Dumping and stacking of aggregates shall be done in an approved manner. In case the Engineer considers that the aggregates are not free from dirt, the same may be washed and drained for at least 72 hours before batching as directed by the Engineer.

602.2.4.3. Fine aggregate: The fine aggregate shall consist of clean natural sand or crushed stone sand or a combination of the two and shall conform to IS: 383. Fine aggregate shall be free from soft particles, clay, shale, loam, cemented particles, mica and organic and other foreign matter. The fine aggregate shall not contain deleterious substances more than the following:

- Clay lumps: 4.0 per cent
- Coal and lignite: 1.0 per cent
- Material passing IS Sieve No. 75 micron: 4.0 per cent

602.2.5. Water: Water used for mixing and curing of concrete shall be clean and free from injurious amount of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in IS: 456.

602.2.6. Mild steel bars for dowels and tie bars: These shall conform to the requirements of IS: 432, IS: 1139 and IS: 1786 as relevant. The dowel bars shall conform to Grade S 240 and tie bars to Grade S 415 of I.S.

602.2.7. Premoulded joint filler: Joint filler board for expansion joints which are proposed for use only at some abutting structures like bridges and culverts shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible material and complying with the requirements of IS: 1838, or BS Specification Clause No. 2630 or Specification for Highway
Works, Vol. I Clause 1015. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths, which shall not be less than one lane width. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

602.2.8. Joint sealing compound: The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide type having flexibility, resistance to age hardening -and durability. If the sealant is of hot poured type it shall conform to AASHTO M282 and cold applied sealant shall be in accordance with BS 5212 (Part 2).

602.9.9. Curing

602.9.9.1. Immediately after the surface texturing, the surface and sides of the slab shall be cured by the application of approved resin-based aluminised reflective curing compound which hardens into an impervious film or membrane with the help of a mechanical sprayer.

Curing compounds shall contain sufficient flake aluminium in finely divided dispersion to produce a complete coverage of the sprayed surface with a metallic finish. The compound shall become stable and impervious to evaporation of water from the surface of the concrete within 60 minutes of application and shall be of approved type. The curing compounds shall have a water retention efficiency index of 90 per cent in accordance with BS Specification No. 7542.

602.9.9.2. The curing compound shall not react chemically with the concrete and the film or membrane shall not crack, peel or disintegrate within three weeks after application. Immediately prior to use, the curing compound shall be thoroughly agitated in its containers. The rate of spread shall be in accordance with the manufacturer's instructions checked during the construction of the trial length and subsequently whenever required by the Engineer. The mechanical sprayer shall incorporate an efficient mechanical device for continuous agitation and mixing of the compound during spraying.

602.9.9.3. In addition to spraying of curing compound, the fresh concrete surface shall be protected for at least 3 hours by covering the finished concrete pavement with tents as described in Clause 602.7.2, during adverse weather conditions as directed by the Engineer. After three hours, the pavement shall be covered by moist hessian and the same shall then be kept damp for a minimum period of 14 days after which time the hessian may be removed. The hessian shall be kept continuously moist. All damaged/torn hessian shall be removed and replaced by new hessian on a regular basis.

602.9.9.4. The Contractor shall be liable at his expense to replace any concrete damaged as a result of incomplete curing or cracked on a line other than that of a joint.

9.0 QUALITY CONTROL IN ROAD WORKS

1.0 GENERAL
1.1. All materials to be used, all methods adopted and all works performed shall be strictly in accordance with the requirements of these Specifications. The Contractor shall set up a field laboratory at locations approved by the Engineer and equip the same with adequate equipment and personnel in order to carry out all required tests and Quality Control work as per Specifications and/or as directed by the Engineer. The list of equipment and the facilities to be provided shall be got approved from the Engineer in advance.

1.2. The Contractor’s laboratory should be manned by a qualified Materials Engineer/Civil Engineer assisted by experienced technicians, and the set-up should be got approved by the Engineer.

1.3. The Contractor shall carry out quality control tests or the materials and work to the frequency stipulated in subsequent paragraphs. In the absence of clear indications about method and or frequency of tests for any item, the instructions of the Engineer shall be followed.

1.4. For satisfying himself about the quality of the materials and work, quality control tests will also be conducted by the Engineer (by himself, by his Quality Control Units or by any other agencies deemed fit by him), generally to the frequency set forth herein under. Additional tests may also be conducted where, in the opinion of the Engineer, need for such test exists.

1.5. The Contractor shall provide necessary co-operation and assistance in obtaining the samples for tests and carrying out the field tests as required by the Engineer from time to time. This may include provision of labour, attendants, assistance in packing and dispatching and any other assistance considered necessary in connection with the tests.

1.6. For the work of embankment, sub grade and pavement, construction of subsequent layer of same or other material over the finished layer shall be done after obtaining permission from the Engineer. Similar permission from the Engineer shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

1.7. The Contractor shall carry out modifications in the procedure of work, if found necessary, as directed by the Engineer during inspection. Works falling short of quality shall be rectified/redone by the Contractor at his own cost, and defective work shall also be removed from the site of works by the Contractor at his own cost.
1.8. The cost of laboratory including services, essential supplies like water, electricity, sanitary services and their maintenance and cost of all equipment, tools, materials, labour and incidentals to perform tests and other operations of quality control according to the Specification requirements shall be deemed to be incidental to the work and no extra payment shall be made for the same. Alternatively, the contractor may choose to test all the required tests to be done on the samples, during construction and as required by ENGINEER-IN-CHARGE in an Engg.college/University/Consultancy firm/reputed laboratory. The above shall be approved by ENGINEER-IN-CHARGE and all the charges shall be borne by the contractor and shall be deemed to be incidental to the work and no extra payment shall be made for the same.

1.9. For testing of samples of soils/soil mixes, granular materials, and mixes, bituminous materials and mixes, aggregates, cores etc., samples in the required quantity and form shall be supplied to the Engineer by the Contractor at his own cost.

1.10. For cement, bitumen, mild steel, and similar other materials where essential tests are to be carried out at the manufacturer’s plants or at laboratories other than the site laboratory, the cost of samples, sampling, testing and furnishing of test certificates shall be borne by the Contractor. He shall also furnish the test certificates to the Engineer.

1.11. For testing of cement concrete at site during construction, arrangements for supply of samples, sampling, testing and supply of test results shall be made by the Contractor as per the frequency and number of tests specified in the Handbook of Quality Control for Construction of Roads and Runways (IRO:SP: I1) and relevant IS Codes or relevant clauses of these Specifications, the cost of which shall be borne by the Contractor.

1.12. The method of sampling and testing of materials shall be as required by the "Handbook of Quality Control for Construction of Roads and Runways" (IRC :SP : 11), and these MOST Specifications. Where they are contradicting, the provision in these Specifications shall be followed. Where they are silent, sound engineering practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contractor.
1.13. The materials for embankment construction shall be got approved from the Engineer. The responsibility for arranging and obtaining the land for borrowing or exploitation in any other way shall rest with the Contractor who shall ensure smooth and uninterrupted supply of materials in the required quantity during the construction period. Similarly, the supply of aggregates for construction of road pavement shall be from quarries approved by the Engineer. Responsibility for arranging uninterrupted supply of materials from the source shall be that of the Contractor.

1.14. **Defective Materials**

All materials which the Engineer/his representative has determined as not conforming to the requirements of the Contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials, which have been subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with any order of the Engineer/his representative, given under this Clause, he Engineer/his representative shall have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payments due to the Contractor.

1.15. **Imported Materials**

At the time of submission of tenders, the Contractor shall furnish a list of materials/finished products manufactured, produced or fabricated outside India which he proposes to use in the work. The Contractor shall not be entitled to extension of time for acts or events occurring outside India and it shall be the Contractor’s responsibility to make timely delivery to the job site of all such materials obtained from outside India.

The materials imported from outside shall conform to the relevant Specifications of the tender. In case where materials/finished products are not covered by the Specifications in the Contract, the details of Specifications proposed to be followed and the testing procedure as well as laboratories/establishments where tests are to be carried out shall be specifically brought out and agreed to in the Contract.

The Contractor shall furnish to the Engineer a certificate of compliance of the tests carried out. In addition, certified mill test reports clearly identified to the lot of materials shall be furnished at the Contractor’s cost.

**2.0 CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY**
2.1. General
All works performed shall conform to the lines, grades, cross sections and dimensions shown
on the drawings or as directed by the Engineer, subject to the permitted tolerances described
herein-after.

2.2. Horizontal Alignment
Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as .
The edges of the carriageway as constructed shall be correct within a tolerance of 10 mm
there from. The corresponding tolerance for edges of the roadway and lower layers of
pavement shall be 20 mm.

2.3. Surface Levels .
The levels of the subgrade and different pavement courses as constructed, shall not vary from
those calculated with reference to the longitudinal and cross-profile of the road as directed by
the Engineer beyond the tolerances mentioned in Table -1.

**TABLE -1 TOLERANCES IN SURFACE LEVELS**

1. Subgrade + 10 mm
   - 15 mm
2. Sub – base + 10 mm
   (a) Flexible Pavement - 15 mm
3. Base – Course for Flexible Pavement + 6 mm
   (a) Bituminous Course - 6 mm
   (b) Other than bituminous + 10 mm
      (i) Machine laid - 10 mm
4. Wearing Course for Flexible Pavement
   (a) Machine laid
       + 6 mm
       - 6 mm
   (b) Manually laid
       + 10 mm
       - 10 mm

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former thereby reduced by more than 6 mm for flexible pavements and 5 mm for concrete pavements.

For checking compliance with the above requirement for sub grade, sub-base and base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 in longitudinally and 3.5 in transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being - not in excess of 5 mm above the permitted tolerance.

For checking the compliance with the above requirement for bituminous wearing courses and concrete pavements, measurements of the surface levels shall be taken on a grid of points spaced at 6.25 m along the length and at 0.5 in from the edges and at the centre of the pavement. In any length of pavement, compliance shall be deemed to be met for the final road surface, only if the tolerance given above is satisfied for any point on the surface.

2.4. Surface Regularity of Pavement Courses

The longitudinal profile shall be checked with a 3 metre long straight edge/moving straight-edge as desired by the Engineer at the middle of each traffic lane along a line parallel to the centre line of the road. The maximum permitted number of surface irregularities shall be as per Table -2.
TABLE - 2 MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES

<table>
<thead>
<tr>
<th>Irregularity Length (m)</th>
<th>Surfaces of carriageways and paved shoulders</th>
<th>Surfaces of lay-byes, service areas and all bituminous base Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>4 mm</td>
<td>4 mm</td>
</tr>
<tr>
<td>75</td>
<td>7 mm</td>
<td>7 mm</td>
</tr>
<tr>
<td>300</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>75</td>
<td></td>
<td>75</td>
</tr>
</tbody>
</table>

National Highways/ Expressways *

|                         | 20       | 9       | 2       | 40       | 18       | 4       | 2       |

Roads of lower category

|                         | 40       | 18      | 4       | 2       | 60       | 27      | 6       | 13      |

* Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 meter long straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

- for pavement surface (bituminous and cement concrete) 3 mm
- for bituminous base courses 6 mm
- for granular sub-base/ base courses 8 mm
- for sub-bases under concrete pavements 10 mm

2.5. Rectification

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfacion of the Engineer.
(i) **Subgrade**: Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recomping to the required density. The degree of compaction and the type of material to be used shall conform to the requirements.

(ii) **Granular Sub-base**: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements.

(iii) **Water Bound Macadam/Wet Mix Macadam Sub-base/Base**: Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to the requirements. This shall also apply to wet mix macadam.

(iv) **Bituminous Constructions**: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recomping to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3.5 m in width.

### 3.0 QUALITY CONTROL TESTS DURING CONSTRUCTION

#### 3.1. General

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the preceding Clauses.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in
Tables -3 and Table-4 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests. Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practise to the directions of the Engineer.

3.2. Tests on Earthwork for Embankment, Subgrade Construction and Cut Formation

3.2.1. Borrow material : Grid the borrow area at 25 m c/c (or closer, if the variability is high) to full depth of proposed working. These pits should be logged and plotted lot proper identification of suitable sources of material. The following tests on representative samples shall be carried out:

(a) Sand Content [IS: 2720 (Part4)]: 2 tests per 3000 cubic metres of soil.
(b) Plasticity Test [IS: 2720 (Part-5)]: Each type to be tested, 2 tests per 30(X) cub. metres of soil.
(c) Density Test [IS:2720 (Par: 8)]: Each soil type to be tested, 2 tests per 3000 cubic metres of soil.
(d) Deleterious Content Test [IS:2720 (Part-27)]: As and when required by the Engineer.
(e) Moisture Content Test (IS :2720 (Part-2)1: One test for every 250 cubic metres of soil.
(f) CBR Test on materials to be incorporated in the subgrade on soaked / unsoaked samples [IS : 2720 (Part-I6)]: One CBR test for every 3000 cu. m. m. atleast or closer as and when required by the Engineer.

3.2.2. Compaction Control : Control shall be exercised on each layer by taking at least one measurement of density for each 1000 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluating a day©s work on statistical basis. The determination of density shall be in accordance with IS: 2720 (Part 23). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 6 (if non-destructive tests are carried out, the number of tests shall be doubled) as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable
variations are observed between individual density results, the minimum number of tests in
one set of measurement shall be increased to 10. The acceptance criteria shall be subject to
the condition that the mean density is not less than the specified density plus:

\[ 1.65 \times \text{standard deviation} \]

(No. of samples) 0.5

However, for earthwork in shoulders (earthen) and in the subgrade, at least one density
measurement shall be taken for every 500 square metres for the compacted area provided
further that the number of tests in each set of measurements shall be at least 10. In other
respects, the control shall be similar to that described earlier.

3.2.3. **Cut formation**: Tests for the density requirements of cut formation shall be carried out
in accordance with Clause 3.2.2.

3.3. **Tests on Sub-bases and Bases (excluding bitumen bound bases)**
The tests and their frequencies for the different types of bases and sub-bases shall be as
given in Table -3. The evaluation of density results and acceptance criteria for compaction
control shall be on lines similar to those set out in Clause 3.2.2.

3.3.1. **Acceptance criteria**: The acceptance criteria for tests on the strength of cement/lime
stabilised soil and distribution of stabiliser content shall be subject to the condition that the
mean value is not less than the specified value plus :

\[ 1.65 \times \text{standard deviation} \]

(No. of samples) 0.5

3.4.2. **Acceptance Criteria**: The acceptance criteria for tests on density and Marshall stability
shall be subject to the condition that the mean value is not less than the specified value plus :

\[ 1.65 \times \text{standard deviation} \]

(No. of samples) 0.5
**TABLE 4. CONTROL TESTS AND THEIR MINIMUM FREQUENCY FOR BITUMINOUS WORKS**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of Construction</th>
<th>Test</th>
<th>Frequency (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prime Coat / Tack</td>
<td>(i) Quality of Binder</td>
<td>Two samples per lot to be subjected to all or some tests as directed by the Engineer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Binder temperature for application</td>
<td>At regular close intervals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Rate of spread of application</td>
<td>Two tests per day</td>
</tr>
</tbody>
</table>
2 Seal Coat / Surface (i) Quality of Binder Two samples per lot
   Dressing Dressing to be subjected
to all or some tests are
directed by the Engineer
   (ii) Aggregate Impact Value One test per 50 m$^3$ of
   - do – aggregate
   (iii) Flakiness Index and
   Elongation Index
   (iv) Stripping Value of
   Aggregates Initially one set of 3
   representative specimens
   for each source of supply.
   Subsequently when
   warranted by changes in
   the quality of aggregates
   - do –
   (v) Water absorption of
   aggregates - do –
   (vi) Grading of aggregates One test per 25 m$^3$ of
   aggregate
   (vii) Stone polishing value
   As required
   (viii) Temperature of binder at
   application At regular close intervals
   (ix) Rate of spread of
   (i) Quality of Binder One test per 500 m$^3$ of
   aggregates
3 Open – graded
   premix Carpet / Mix
   Seal Surfacing –
   (i) Quality of Binder Two samples per lot to be
   subjected to all or some
   tests are directed by the
   Engineer
   (ii) Aggregate Impact Value One test per 50 m$^3$ pf
   aggregate
   - do –
   (iii) Flakiness Index and
   Elongation Index of
   aggregates
   (iv) Stripping Value of
   Aggregates Same as mentioned
   under serial no. 2
   (v) Water absorption of
   aggregates Same as mentioned
   under serial no. 2
   (vi) Grading of aggregates One test per 25 m$^3$ of
   aggregate
   (vii) Stone polishing value
   As required
   (viii) Temperature of binder at
   application At regular close intervals
   Two tests per day
   (ix) Binder Content
   Regular control through
   checks on materials and
   layer thickness
   (x) Rate of spread of mixed
   material
   Bituminous
   Macadam
   (i) Quality of Binder Two samples per lot to be
   subjected to all or some
   tests are directed by the
   Engineer
   (ii) Aggregate Impact Value One test per 50 m$^3$ of
   aggregate
   - do –
   (iii) Flakiness Index and
   Elongation Index of
   aggregates

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Stripping Value of Aggregates
Same as mentioned under serial no. 2

(v) Grading of Aggregates
Two tests per day per plant both on the individual constituents and mixed aggregates from the dryer

(vi) Water absorption of aggregates
Same as in Serial No. 2

(vii) Binder content
Periodic, Subject to minimum of two tests per day per plant

(viii) Control of temperature of binder and aggregate for mixing and of the mix at the time of laying and rolling
At regular close intervals

Regular control through checks of layer thickness

SAFETY REQUIREMENT FOR CONSTRUCTION WORKS

A GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.

In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the Contractor and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work:

6.0 Athletic Track CONSTRUCTION WORKS

SCOPE OF synthetic WORK
Scope of work shall include but not limited to Laying and execution synthetic athletic tracks of 8 lane, Full 10 mm thick Polyurethane SBR with 5 mm EPDM turf totaling to minimum 15mm at RGUKT Basar as per the Standards including all necessary allied drainage works over even surface after filling of Sandy earth as per drawings, Technical specifications and bill of quantities and complete in all respect.

ACCEPTABLE MAKES OF MATERIAL
1) APT / Rekortan
2) Ebaco
3) Elastomer
4) Ecotex
Note: The final approval of the brand to be used shall be as per the direction of Engineer-in-Charge. The brand used shall be one of the brands in case specified in the list of preferred make / materials.

TECHNICAL SPECIFICATIONS OF SYNTHETIC ATHLETIC TRACK

a) Full PUR Synthetic Tracks
The work shall be carried out as per the following Standards of IAAF:

Base Layer : Polyurethane embedded with SBR granules
Top Layer : Polyurethane embedded with UV resistant EPDM rubber granules.

The installation of any polymeric synthetic athletics track surface should be done during the spring/summer/dry months.

Before laying of the Shock absorbing layer and synthetic surface, the following checks should be carried out by the contractors.

- The surface area should be flooded with water, to ensure there is no stagnation more than the permissible limits.
- The layout of the Athletic track is as per approved drawings & technical specifications. Contractor shall be responsible for all the dimensions and slopes.
- Synthetic surface shall laid directly by the manufacture through their approved applicator only as per their installation manual.
- Line markings of the surface should be as per the specifications.

b) Testing of Synthetic Surface
Contractor shall send the sample of laid synthetic surface of SBR /EPDM truf track of minimum thickness of 15mm with MTC result to EPI/Client along with bill of the work. The size of the samples should not be less than 600mm X 600mm.

c) The costing includes the following:

- No payment shall be made for any damage caused by rain, snowfall, flood or any other natural calamity, whatsoever during the execution of the work. The contractor shall be fully responsible for any damage to the govt. property and work for which the payment has been advanced to him under the contract and he shall make good the same at his risk and cost. The contractor shall be fully responsible for safety and security of his material, T&P, Machinery brought to the site by him.

- Any cement slurry added over base surface (or) for continuation of concreting for better bond is deemed to have been in-built in the items and nothing extra shall be payable (or) extra cement considered in consumption on this account.

- The contractor shall give a performance test of the entire installation (s) as per standing specification before the work is finally accepted and nothing extra whatsoever shall be payable to the contractor for the test.
• The contractor shall get the water tested with regard to its suitability of use in the works and get written approval from the Engineer in charge before he proceeds with the use of the same execution of works. The suitable water for construction shall be arranged by Contractor at his own cost and nothing extra shall be paid to the contractor on this account.

• It must be ensured that all materials to be used in work bear BIS certification mark. In cases where BIS certification system is available for a particular material/product but not even a single producer has so far approached BIS for certification the material can be used subject to the condition that it should confirm to CPWD specification and relevant BIS codes. In such case written approval of the Engineer-In-Charge may be obtained before use of such material in the work.

• The final approval of the brand to be used shall be as per the direction of Engineer-in-Charge. The brand used shall be one of the brands in case specified in the list of preferred make/materials.

• The cost will inclusive of adhesive, surface preparation, joints and all men and materials to complete the work in all respect.

• Plan surface only to be measured for payment, wastage and laps will not be consider separately.
7.0 LIST OF SPECIFICATIONS FOR THE VARIOUS ITEMS OF WORKS SUPPLEMENTING THOSE DESCRIBED IN SCHEDULE ‘A’ BY S.S. NUMBERS

GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Short title/ Description</th>
<th>IS.No. and as amended from time to time</th>
</tr>
</thead>
</table>

**A) LIST OF INDIAN STANDARDS**

**I. CEMENT**

1. Specifications for 43 Grade ordinary portland cement  
   IS 8112:1989

2. Methods of physical tests for hydraulic comments  
   IS 4031 (part 1 to 15) :1988

3. 53 Grade cement  
   IS 12269:1989

II. AGGREGATES

1. Specifications for Coarse and Fine aggregates from Natural resources for concrete  
   IS 383:1970

2. Specification for Sand for Masonry  
   IS 2116:1980

3. Methods of tests for aggregates for concrete. Part-1 Particle seize and shape  
   IS 2386:1963 (Part I to IV)

   Schedule - B Estimation of deleterious materials & Organic impurities  
   Part-III – Soundness

4. Specification for test sieves. Part-I Wire cloth test sieves  
   IS 460:1978 (Part-I)

III. BRICKS

1. Specifications for Common burnt clay building bricks  
   IS 1077:1992

2. Methods of test for burnt clay building bricks  
   IS 3495:1992 (Part I to IV)

   IS 12894:2002

4. Specification for concrete masonry units Part 3 Autoclaved cellular Aerated concrete blocks  
   IS 2185:1984 (Part-III)

IV. BUILDING STONES:

1. Method of Tests for determination of strength properties of natural building stones (compressive strength, Transverse strength, Tensile Strength, Shear Strength.  
   IS 1121 (Part –1 to Part 4): 1974

2. Schedule of properties and availability of stones for construction purposes  
   IS 7779:1975 (Part 1 to Part 5)

3. Quarrying stones for construction purposes, recommended practice  
   IS 8381:1977

4. Stone Masonry: Specifications for dressing natural building stones  
   IS 1129:1972 (Part-IV)

V. STEEL

1. Specification of Mild steel and medium tensile steel bars and hard drawn steel wires for concrete reinforcement.  
   IS 432:1982 (Part I)
<table>
<thead>
<tr>
<th>Sl.No.</th>
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<th>IS.No. and as amended from time to time</th>
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<tbody>
<tr>
<td>1</td>
<td>Part-I Mild Steel &amp; Medium tensile steel bars</td>
<td>IS 1786:1985 &amp; II)</td>
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<tr>
<td>2</td>
<td>Specifications for Cold-worked steel, High strength deformed steel bars and wires for concrete reinforcement.</td>
<td>IS 2062:1999</td>
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<tr>
<td>3</td>
<td>Specification for steel for General structural purposes</td>
<td>IS 226:1975</td>
</tr>
<tr>
<td>4</td>
<td>Specification for structural steel (Standard quality)</td>
<td>IS 1161:1998</td>
</tr>
<tr>
<td>5</td>
<td>Specification for steel tubes for structural purposes</td>
<td>IS 432:1953</td>
</tr>
<tr>
<td>VI</td>
<td>MASONRY</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Brick Masonry</td>
<td>IS 2212:1962</td>
</tr>
<tr>
<td>2</td>
<td>Code of practice for construction of Stone Masonry Part-1 (Rubble stone masonry)</td>
<td>IS 1597:1992</td>
</tr>
<tr>
<td>3</td>
<td>Code of practice for permeability test for masonry (during and after construction)</td>
<td>IS 11216:1985</td>
</tr>
<tr>
<td>4</td>
<td>Code of practice for brick work</td>
<td>IS 2212:1991</td>
</tr>
<tr>
<td>5</td>
<td>Construction of hallow and solid concrete block masonry</td>
<td>IS 2572:2005</td>
</tr>
<tr>
<td>6</td>
<td>Code of practice for construction of autovlaved cellular concrete block masonry</td>
<td>IS 6041:1985</td>
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<tr>
<td>VII</td>
<td>CONCRETE</td>
<td></td>
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<tr>
<td>2</td>
<td>Method of Sampling and analysis of concrete</td>
<td>IS 1199:1959</td>
</tr>
<tr>
<td>3</td>
<td>Method of test for strength of concrete</td>
<td>IS 516:1959</td>
</tr>
<tr>
<td>4</td>
<td>Recommended guide lines for Concrete Mix Design</td>
<td>IS 10262:1982</td>
</tr>
<tr>
<td>5</td>
<td>Code of practice for Ready-Mixed Concrete</td>
<td>IS 4926:2003</td>
</tr>
<tr>
<td>6</td>
<td>Specification for Admixtures for concrete</td>
<td>IS 9103:1999</td>
</tr>
<tr>
<td>7</td>
<td>Guidelines for false work for concrete structures.</td>
<td>IS:14687:1999</td>
</tr>
<tr>
<td>8</td>
<td>Code of practice for use of immersion vibrators for consolidating concrete</td>
<td>IS 3558:1983</td>
</tr>
<tr>
<td>9</td>
<td>Specifications for Pre-cast concrete coping blocks</td>
<td>IS 5751:1984</td>
</tr>
<tr>
<td>10</td>
<td>Laying in situ cement concrete flooring</td>
<td>IS 2571:1970</td>
</tr>
<tr>
<td>12</td>
<td>Code of practice for concrete roads</td>
<td>IRC: 15-2002</td>
</tr>
</tbody>
</table>

Note:- The above I.S specifications mean latest over and above with amendments if any.