

Name of work

**Providing and laying of Cement Grouted Bituminous  
Concrete on existing bituminous roads in IIT Kanpur  
campus**

*BID DOCUMENT*



OFFICE OF INFRASTRUCTURE AND PLANNING  
INDIAN INSTITUTE OF TECHNOLOGY KANPUR  
February, 2024

# Indian Institute of Technology Kanpur

## Contents

	Page
<b>1 Notice Inviting e-Tenders</b>	<b>1</b>
<b>2 Information and Instructions for Bidders for E-Tendering</b>	<b>3</b>
2.1 Schedule . . . . .	3
2.2 Instructions for Online BID Submission . . . . .	9
2.2.1 Registration . . . . .	10
2.2.2 Searching for tender documents . . . . .	10
2.2.3 Preparation of bids . . . . .	10
2.2.4 Submission of bids . . . . .	11
2.2.5 Assistance to bidders . . . . .	12
2.2.6 General instruction to bidders . . . . .	12
2.3 <a href="#">List of documents to be scanned and uploaded within the period of bid submission</a>	13
2.3.1 Envelope - 1: Technical Bid . . . . .	13
2.3.2 Envelope - 2: Financial Bid . . . . .	13
<b>3 Eligibility Criteria</b>	<b>14</b>
3.1 Eligibility criteria for contractors . . . . .	14
<b>4 Bid Evaluation</b>	<b>16</b>
4.1 Technical Bid Evaluation . . . . .	16
4.2 Financial Bid Evaluation . . . . .	17
<b>5 Integrity Pacts</b>	<b>18</b>
5.1 Section 1: Commitments of the Principal . . . . .	18
5.2 Section 2: Commitments of the Bidder(s)/Contractor(s) . . . . .	19
5.3 Section 3: Disqualification from tender process and exclusion from future contracts	20
5.4 Section 4: Compensation for Damages . . . . .	20
5.5 Section 5: Previous Transgression . . . . .	20
5.6 Section 6: Equal treatment of all Bidders / Contractors / Sub-Contractors . . . . .	20
5.7 Section 7: Criminal charges against violating Bidder(s) / Contractor(s) / Sub-contractors(s) . . . . .	20
5.8 Section 8: Independent External Monitor . . . . .	21
5.9 Section 9: Pact Duration . . . . .	21
5.10 Section 10: Other Provisions . . . . .	22
<b>6 Various Forms and Formats</b>	<b>23</b>
6.1 Declaration in lieu of submitting Earnest Money Deposit . . . . .	23
6.2 Format for submission of processing fees . . . . .	24
6.3 Undertaking regarding obtaining GST registration . . . . .	25
6.4 Affidavit for not being blacklisted/debarred/restrained . . . . .	26

6.5	Financial Information . . . . .	27
6.6	Banker's Certificate from a scheduled Bank . . . . .	28
6.7	Net Worth Certificate by certified Chartered Accountant . . . . .	29
6.8	Performance report on work executed . . . . .	30
6.9	Structure and Organization of the Agency . . . . .	31
6.10	Declaration on Details of the Bidders . . . . .	32
6.11	Details of Similar Nature of Works Completed . . . . .	34
6.12	Declaration About Site Inspection . . . . .	35
6.13	Letter of Transmittal . . . . .	36
6.14	CPWD-7 . . . . .	37
<b>7</b>	<b>Proforma of Schedules</b>	<b>39</b>
7.1	<b>SCHEDULE 'A':</b> Schedule of Quantities . . . . .	39
7.2	<b>SCHEDULE 'B':</b> Schedule of materials to be issued to the contractor . . . . .	39
7.3	<b>SCHEDULE 'C':</b> Tools and plants to be hired to the contractor . . . . .	39
7.4	<b>SCHEDULE 'D':</b> Extra schedule for specific requirements/document for the work, if any . . . . .	39
7.5	<b>SCHEDULE 'E':</b> Reference to General Conditions of contract . . . . .	39
7.6	<b>SCHEDULE 'F':</b> General Rules and Directions . . . . .	39
7.6.1	Definitions . . . . .	40
7.6.2	Clauses . . . . .	40
<b>8</b>	<b>Scope of work</b>	<b>46</b>
8.1	List of Preferred Makes for Road Works (as applicable) . . . . .	46
<b>9</b>	<b>Special Conditions of Contract</b>	<b>48</b>
9.1	Timely Completion . . . . .	48
9.2	Rates . . . . .	48
9.3	Quality and Workmanship . . . . .	49
9.4	Natural calamity . . . . .	51
9.5	Stocking and Disposal of Materials & Debris . . . . .	51
9.6	Painting, if applicable . . . . .	52
9.7	Safety and Security . . . . .	52
9.8	Approach to Site . . . . .	53
9.9	Water and Flooding . . . . .	53
9.10	Acts and Laws . . . . .	53
9.11	Labour and Laws . . . . .	54
9.12	Nondisclosure Agreement . . . . .	54
9.13	Indemnification: . . . . .	54
9.14	Force Majeure: . . . . .	54
9.15	Dispute resolution . . . . .	55
9.16	Arbitration . . . . .	55
9.17	Jurisdiction of Courts . . . . .	56
9.18	<b>Special Conditions for Road Works</b> . . . . .	56
9.18.1	Conditions for Bitumen . . . . .	57
9.19	<b>Particular Specifications for Road Work</b> . . . . .	58

*It is certified that this document contains 116 pages starting with Page No. i*  
Officer-in-Charge, Office of Infrastructure and Planning

## 1 Notice Inviting e-Tenders

The Dean of Infrastructure and Planning on behalf of Board of Governors of Indian Institute of Technology Kanpur invites online [percentage rate tenders from eligible firms/ specialized agencies satisfying the eligibility criteria mentioned in the document.](#)

NIT No: [Civil/27/02/2024-1](#)

1	Name of work	: <b>Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus</b>
2	Estimated Cost exclusive of GST	: <b>Rs. 1,10,39,946/-</b>
3	Earnest Money Deposit (Rs.)	: EMD Declaration to be submitted in lieu of EMD as per <a href="#">Form 6.1</a>
4	Duration of contract	: <b>Three (3) months</b>
5	Last Time & date of submission of bids (Up to)	: As per CPP portal data ( <a href="https://eprocure.gov.in/eprocure/app">https://eprocure.gov.in/eprocure/app</a> )
6	Opening of bids	: As per CPP portal data
7	Time allowed for submission of requisite documents by lowest bidder	: Within <b>One week</b> of opening of financial bids

The bid forms and other details may be downloaded from Central Public Procurement Portal (<http://eprocure.gov.in/eprocure/app>). Aspiring bidders who have not enrolled / registered in e-procurement should enroll / register themselves before participating through web site <http://eprocure.gov.in/eprocure/app>. The portal enrolment is free of cost. Bidders are advised to go through instructions provided at “Instructions for online bid submission.”

Bidders can access quotation / tender documents on the website (for searching in the NIC site), kindly go to quotation search option and type ‘IIT’. Thereafter, click on “GO” button to view all IIT quotations. Select the appropriate quotation / tender and fill them with all relevant information and submit the completed Quotation / Tender document online on the website <http://eprocure.gov.in/eprocure/app> as per the schedule given in the next page.

**Note: No manual bids will be accepted. All bids (both Technical & Financial) should be submitted in the e-procurement portal.**

Applicants are advised to keep visiting the above-mentioned websites from time to time (till the deadline for bid submission) for any updates in respect of the tender documents, if any. Failure to do so shall not absolve the applicant of his liabilities to submit the applications complete in all respect including updates thereof, if any. An incomplete application may be liable for rejection.

Officer-in-Charge, Office of Infrastructure and Planning

## 2 Information and Instructions for Bidders for E-Tendering

The Dean of Infrastructure and Planning on behalf of Board of Governors of Indian Institute of Technology Kanpur invites online [percentage rate tenders from eligible firms/ specialized agencies satisfying the eligibility criteria mentioned in the document.](#)

### 2.1 Schedule

1	Name of organization	:	Indian Institute of Technology Kanpur
2	NIT No:	:	<a href="#">Civil/27/02/2024-1</a>
	Location	:	Indian Institute of Technology Kanpur
3	Tender / Quotation type (open / limited / EOI / auction / single)	:	Open
4	Tender / Quotation category (services / goods / works)	:	Works
5	Type of Contract (work / supply / auction / service / buy / empanelment / sell)	:	Work
6	Form of contract (IITK-7/8)	:	IITK-7
7	Work Category (civil / electrical / fleet management / computer systems)	:	Civil
8	Is multi-currency allowed?	:	No
9	Date of publishing / issue / start	:	As per CPP portal
10	Document download start date	:	As per CPP portal
11	Document download end date	:	As per CPP portal
12	Date & time of pre-bid meeting	:	As per CPP portal
13	Venue of pre-bid meeting	:	As per CPP portal
14	Last date & time of uploading of bids	:	As per CPP portal
15	Date & time of opening of Technical bids	:	As per CPP portal
16	Bid Validity Days	:	<a href="#">90 days after opening of technical bid</a>
17	Earnest Money Deposit (EMD)	:	<a href="#">EMD Declaration to be submitted in lieu of EMD as per FORM 6.1</a>

<b>18</b>	Non- Refundable Processing Fee (Inclusive of GST @18%) as given in section 6.2	Rs. 40,000/-for Non MSME/NSIC/Startup and Rs. 10,000/-for MSME/NSIC/Startup to The Registrar, Indian Institute of Technology Kanpur. The proof of submission must be uploaded along with transaction slip with due mention of NIT No. in the CPP portal for valid tender submission as per format given in section 6.2
<b>19</b>	No. of Bids / Covers (1 / 2 / 3 / 4)	: 2
<b>20</b>	Address for communication	: Office of Infrastructure and Planning, Indian Institute of Technology Kanpur, Kanpur, U.P. Pin - 208016
<b>21</b>	e-mail address	: <a href="mailto:tender_doip@iitk.ac.in">tender_doip@iitk.ac.in</a>

The intending bidder must read the terms and conditions of CPWD-6 carefully. He should only submit his bid if he considers himself eligible and he is in possession of all the documents required.

1. Information and instructions for bidders posted on website shall form part of bid document.
2. The bid document consisting of drawings, specifications, schedule of quantities of items to be executed, schedule of stages for payment as applicable and the set of terms & conditions of the contract to be complied with and other necessary documents can be seen and downloaded free of cost from [www.eprocure.gov.in](http://www.eprocure.gov.in)
3. But the bid can only be submitted after deposition of e processing fee and with the EMD declaration.
4. Those contractors not registered on the website mentioned above, are required to get registered beforehand. Only e-bids shall be accepted in CPPP portal through e-tendering processes.
5. The intending bidder must have valid Class-III digital signature to submit the bid.
6. On opening date, the contractor can login and see the bid opening process. After opening of bids, he will receive the competitor bid sheets.
7. Contractor can upload documents in the form of JPG format and PDF format.
8. Contractor must ensure to quote rate of each item. The column meant for quoting rate in figures appears in pink colour and the moment rate is entered, it turns sky blue.

In addition to this, while selecting any of the cells a warning appears that if any cell is left blank the same shall be treated as "0". Therefore, if any cell is left blank and no rate is quoted by the bidder, rate of such item shall be treated as "0" (ZERO).

However, if a tenderer quotes nil rates against each item in item rate tender or does not quote any percentage above/below on the total amount of the tender or any section / sub head in percentage rate tender, the tender shall be treated as invalid and will not be considered as lowest tenderer.

9. The “Eligibility/technical Bid” shall be opened first on due date and time as per the evaluation scheme. The “Financial Bid” of bidders qualifying the technical bid shall be opened on a later date as to be announced in CPP portal.
10. The bidders are advised to visit the site before submission of bids to have more clarity about the site conditions and availability of space for execution of the work.
11. All modifications/addendums/corrigendums issued regarding this bidding process shall be uploaded on website only.
12. The department reserves the right to reject any or all bids without assigning any reason thereof and may restrict the list of qualified bidders to any number deemed suitable by it, if too many bids are received satisfying the minimum laid down criteria.
13. Integrity pact of the tender document shall be signed between Dean of Infrastructure and Planning and the successful bidder after acceptance of the tender
14. The rates for all items of work, shall unless clearly specified otherwise, include cost of all operations and all inputs of labour, material, T&P, wastages, watch and ward, other inputs, all incidental charges, all other taxes (exclusive of GST), cess, duties, levies etc. required for execution of the work.
15. The specialized works shall be in compliance with 3 Star GRIHA rating and as per environmental policies of Institute. Nothing extra shall be payable on this account. **The contractor have to ensure the site free from dust and any kind of pollutants during the course of work and sufficient sprinkling activity should be performed to control the dust and pollution during the duration of contract.**
16. If applicable, The enlistment of the contractors should be valid on the last date of submission of bids. In case the last date of submission of bid is extended, the enlistment of contractor should be valid on the original date of submission of bids.
17. The description of the work is as follows: **“Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus”**
18. The work is estimated to cost **Rs.1,10,39,946/-**. However, this estimate given is mere approximation for guide.
19. Agreement shall be drawn with the successful bidders on prescribed Form No. CPWD 7 which is available as a Govt. of India Publication and also available on website [www.cpwd.gov.in](http://www.cpwd.gov.in). Bidders shall quote his rates as per various terms and conditions of the said form which will form part of the agreement.
20. The time allowed for carrying out the entire work will be **Three (3) months** from the date of start as defined in Schedule “F” or from the first date of handing over of the site, whichever is later, in accordance with the phasing as detailed in special conditions of contract in the bid document.
21. The site for the work will be handed over as per the special terms and conditions of the document.

22. An approved programme of completion submitted by the contractor after award of work based on the milestones given in the tender.
23. The bid document consisting of NIT, the schedule of quantities of various types of items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents can be seen and downloaded from website [www.eprocure.gov.in](http://www.eprocure.gov.in) free of cost.
24. After submission of the bid the contractor can re-submit revised bid any number of times but before last time and date of submission of bid as notified.
25. While submitting the revised bid, contractor can revise the rate of one or more item(s) any number of times (he need not re-enter rate of all the items) but before last time and date of submission of bid as notified.
26. Earnest Money Declaration shall be uploaded to the e-Tendering website within period of submission
27. The receipt of e-processing fee shall also be uploaded to the e-tendering website by the intending bidder up to the specified bid. The Details of Institute Account for submitting e-processing fees is given in 6.2 under Section [Various Forms and Formats](#).
28. Copy of documents as specified in the bid shall be scanned and uploaded to the e-tendering website within the period of bid submission.
29. The bid submitted shall be opened at as per the details provided in the CPP portal at DOIP office. The date of opening of Financial Bid shall be informed through web site after the opening of technical bid.
30. [The bid submitted shall become invalid and e- processing fee shall not be refunded if:](#)
  - (i) The bidder is found ineligible.
  - (ii) The bidder does not upload scanned copies of all the documents stipulated in the bid document.
  - (iii) If a tenderer quotes nil rates against each item in item rate tender or does not quote any percentage above/below on the total amount of the tender or any section / sub head in percentage rate tender, the tender shall be treated as invalid and will not be considered as lowest tenderer.
31. The contractor whose bid is accepted will be required to furnish performance guarantee of [5% of tendered value](#) within the period specified in Schedule F. This guarantee shall be in the form of or Deposit at Call receipt of any scheduled bank/ Banker's cheque of any scheduled bank/ Demand Draft of any scheduled bank/ Pay order of any Scheduled Bank of any scheduled bank (in case guarantee amount is less than Rs. 1,00,000/-) or Government Securities or Fixed Deposit Receipts or Guarantee Bonds of any Scheduled Bank or the State Bank of India in accordance with the prescribed form.
32. In case the contractor fails to deposit the said performance guarantee within the period as indicated in Schedule 'F' including the extended period if any, the contractor shall be suspended for [two years and shall not be eligible to bid for IITK tenders from the date of issue of suspension order](#).
33. The contractor whose bid is accepted will also be required to furnish either copy of applicable licenses/ registrations or proof of applying for obtaining licenses, registration

with EPFO, ESIC and BOCW Welfare Board including Provident Fund Code No. If applicable and also ensure the compliance of afore said provisions by the sub-contractors, if any engaged by the contractor for the said work and program chart (Time and Progress) within the period specified in Schedule 'F'.

34. Intending Bidders are advised to inspect and examine the sites and its surroundings and satisfy themselves before submitting their bids as to the nature of the ground and sub-soil (so far as is practicable), the form and nature of the site, the means of access to the site, making proper arrangements to the site for smooth operation, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their bid. Bidder shall be deemed to have full knowledge of the sites whether he inspects it or not and no extra charge consequent on any misunderstanding or otherwise shall be allowed. The bidder shall be responsible for arranging and maintaining at his own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by a bidder implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and of conditions and rates at which stores, tools and plant, etc. will be issued to him by the Institute and local conditions and other factors having a bearing on the execution of the work.
35. Intending Bidders are advised to get familiarized with the specifications /rules related (i.e., [Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus](#)) to the work as approved by the competent authority and various policies related to c&d waste and other environmental guidelines of the institute pertaining to the. Bidder shall be deemed to have full knowledge of such rules and regulations whether he has read it or not and no extra charge consequent on any misunderstanding or otherwise shall be allowed. In case of reduction of scope of work or no work is possible to carry out on account of such issues, no cost shall be payable to them. Submission of a bid by the bidder implies that he has read this notice and all other documents and has made himself aware of the Institute Regulations and other factors having a bearing on the execution of the work.
36. The competent authority on behalf of the Board of Governors does not bind itself to accept the lowest or any other bid and reserves to itself the authority to reject any or all the bids received without assigning any reason. Bids in which any of the prescribed conditions is not fulfilled or any condition including that of conditional rebate is put forth by the bidders shall be summarily rejected.
37. Canvassing whether directly or indirectly, in connection with bids is strictly prohibited and the bids submitted by the bidders who resort to canvassing will be liable to rejection.
38. The competent authority on behalf of the Board of Governors reserves to himself the right of accepting the whole or any part of the bid and the bidders shall be bound to perform the same at the rate quoted.
39. The contractor shall not be permitted to bid for works in the [Office of Infrastructure and Planning / Institute Works Department responsible for award and execution of contracts](#), in which his near relative is posted as Divisional Accountant or as an officer in any capacity between the grades of [Superintending Engineer and Junior Engineer \(both inclusive\) in IWD and Office of Infrastructure and Planning](#). He shall also intimate the names of persons

who are working with him in any capacity or are subsequently employed by him and who are near relatives to any gazetted officer in the Office of Infrastructure and Planning/ Institute Works Department. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of this Department.

40. No Engineer of Gazetted Rank or other Gazetted Officer employed in Engineering or Administrative duties in an Engineering Department of the Government of India is allowed to work as a contractor for a period of one year after his retirement from Government service, without the prior permission of the Government of India in writing. This contract is liable to be canceled if either the contractor or any of his employees is found any time to be such a person who had not obtained the permission of the Government of India as aforesaid before submission of the bid or engagement in the contractor's service.
41. The bids for the work shall remain open for acceptance for a period of **Ninety (90) days** from the date of opening of bids. If any bidder withdraws his bid before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the bid which are not acceptable to the department, then the Institute shall, without prejudice to any other right or remedy, be at liberty to suspend the bidder for one year
42. This Notice Inviting Bid shall form a part of the contract document. The successful bidders/contractor, on acceptance of his bid by the Accepting Authority shall within 7 days from the stipulated date of start of the work, will sign the contract.
43. The Notice Inviting Bid, all the documents including additional conditions, specifications and drawings, if any, forming part of the bid as uploaded at the time of invitation of bid and the rates quoted online at the time of submission of bid and acceptance thereof together with any correspondence leading thereto
44. Standard C.P.W.D. Form 7 or other Standard C.P.W.D. Form as applicable.
45. The bid document will include the following components:
  - (a) CPWD-7 and CPWD-6 including **Schedule A** to F for all the components of the work, Standard General Conditions of Contract for CPWD 2023 as amended/modified up to last date of submission of the bid.
  - (b) General / specific conditions, specifications applicable to all components of the work.
46. The eligible bidders shall quote percentage rates after considering all the components of the work.
47. After acceptance of the bid by competent authority, the Dean, Infrastructure and Planning shall issue letter of award on behalf of the Board of Governors to the contractor. After the work is awarded, the contractor will have to enter into one agreement with Dean, Infrastructure and Planning. One such signed set of agreement shall be handed over to Engineer-In-Charge as applicable.
48. Entire work under the scope of bid shall be executed under one agreement.
49. The requirement of technical staff given in various specialized works is as per requirements given in clause 32 of NIT document. The actual deployment of these technical staff will be as per execution of work and direction of the **Dean of Infrastructure and Planning, IITK**.
50. **Running bill must be generated based on the work component decided for execution as**

directed by Engineer In Charge as per the tender clauses. The work of each component must be satisfactorily executed before a running bill is cleared by the Engineer In Charge. The payment shall be based on milestones.

51. The bills for work components shall be facilitated by Engineer-in-Charge to the contractor and the bills must be submitted to the Office of Infrastructure and Planning, IIT Kanpur.
52. The work shall be treated as complete when all the components of the work are complete.
53. It will be obligatory on the part of bidder to sign the contract document for all components before the first payment is released.
54. In case of reduction in scope of work no claim on account of reduction in value of work, loss of expected profit, consequential overheads etc. shall be entertained.
55. Integrity Pact: The contractor shall download the Integrity Pact, which is a part of tender documents, affix his signature in the presence of a witness, and upload the same while submitting online bids. In the event of his failure to sign and upload the Integrity Pact along with other bid documents, his bid shall be rejected
56. A team of officers from Indian Institute of Technology Kanpur may visit the office/ site of work of bidders for establishing their credibility and verification of submitted documents
57. The mentioned work is urgent as requested by client/Institute and to be completed strictly in given time schedule as per special terms and conditions. The contractor has to deploy the labour and supervisory staff in shifts to meet the targeted completion date. The work may be executed in extended shifts or two shifts. The rates quoted by the contractor will be deemed to be inclusive of any extra expenditures on account of this reason. Nothing shall be paid on this account.
58. **The competent authority on behalf of the Board of Governors reserves the right to terminate the contract if,**
  - (a) **Any violation of labour law has been observed.**
  - (b) **Any of the construction workers engaged in the works under this contract is found also engaged in Service Contracts of the Institute at the same time.**
59. **The competent authority on behalf of the Board of Governors reserves the right to disqualify an agency for**
  - (a) **Non-compliance of Institute orders**
  - (b) **Violation of Institute policies****as established by the Competent Authority in the best interests of the Institute.**

## **2.2 Instructions for Online BID Submission**

This tender document has been published on the Central Public Procurement Portal (URL: <http://eprocure.gov.in/eprocure/app>). The bidders are required to submit softcopies of their bids electronically on the CPP portal, using valid Digital Signature Certificates (DSC). The instructions given below are meant to assist the bidders in registering on the CPP portal, prepare their bids in accordance with the requirements and submitting their bids online on the CPP portal.

More information useful for submitting online bids on the CPP portal may be obtained at <http://eprocure.gov.in/eprocure/app>

### **2.2.1 Registration**

1. Bidders are required to enroll on the e-procurement module of the Central Public Procurement portal (URL:<http://eprocure.gov.in/eprocure/app>) by clicking on the link, “click here to enroll”. Enrolment on the CPP portal is free of charge
2. As part of the enrolment process, the bidders will be required to choose a unique username and assign a password for the accounts.
3. Bidders are advised to register their valid e-mail address and mobile number as part of the registration process. These would be used for any communication from the CPP portal.
4. Upon enrolment, the bidders will be required to register their valid Digital Signature Certificate (class 2 or class 3 certificates with signing key usage) issued by any certifying authority recognized by CCA India (e.g. Sify / TCS / nCode/ eMudhra etc.) with their profile.
5. Only one valid DSC should be registered by a bidder. Please note that bidders are responsible to ensure that they do not lend their DSCs to others which may lead to misuse.
6. Bidder then logs in to the site through the secured log-in by entering their user ID Password and the password of the DSC / eToken.

### **2.2.2 Searching for tender documents**

1. There are various search options built in the CPP portal to facilitate bidders to search active tenders by several parameters. These parameters could include tender ID, organization name, location, date, value, etc. There is also an option of advanced search for tenders, wherein the bidders may combine a number of search parameters such as organization name, form of contract, location, date, other keywords etc. to search for a tender published on the CPP portal.
2. Once the bidders have selected the tenders they are interested in, they may download the required documents / tender schedules. The tenders can be moved to the respective “My Tenders” folder. This would enable the CPP portal to intimate the bidders through SMS / e-mail in case there is any corrigendum issued to the tender document.
3. The bidder should make a note of the unique Tender ID assigned to each other; in case they want to obtain any clarification/help from the Helpdesk.

### **2.2.3 Preparation of bids**

1. Bidder should take into account any corrigendum published on the tender document before submitting their bids.
2. Please go through the tender advertisement and the tender document carefully to understand the documents required to be submitted as part of the bids. Please note the number of covers in which the bid documents have to be submitted. Any deviations from these may lead to rejection of the bids.

3. Bidder, in advance, should get ready the bid documents to be submitted as indicated in the tender document / schedule and generally, they can be in PDF / XLS / RAR / DWF formats. Bid documents may be scanned with 100 dpi with black & white option.
4. To avoid the time and effort required in uploading the same set of standard documents which are required to be submitted as a part of every bid, a provision of uploading such standard documents (e.g., PAN card copy, annual reports, auditor's certificates, etc.) has been provided to the bidders. Bidders can use "My Space" area available to them to upload such documents. These documents may be directly submitted from the "My Space" area while submitting a bid, and need not be uploaded again and again. This will lead to a reduction in the time required for bid submission process.

#### **2.2.4 Submission of bids**

1. Bidder should log into the site well in advance for bid submission so that he / she upload the bid in time i.e. on or before the bid submission time. Bidder will be responsible for any delay due to other issues.
2. The bidder has to digitally sign and upload the required bid documents one by one as indicated in the tender document.
3. Bidder has to select the payment option as "on-line" to pay the EMD as applicable and enter details of the instrument
4. A standard BOQ Format has been provided with the tender document to be filled by all the bidders. Bidders are requested to note that they should necessarily submit their financial bids in the format provided and no other format is acceptable. Bidders are required to download the BOQ file, open it and complete the white colored [unprotected] cells with their respective financial quotes and other details (such as name of the bidder). No other cells should be changed. Once the details have been completed, the bidder should save it online, without changing the filename. If the BOQ file is found to be modified by the bidder, the bid will be rejected.

OR

In some cases, financial bids can be submitted in PDF format as well (in lieu of BOQ).

5. The server time (which is displayed on the bidders' dashboard) will be considered as the standard time for referencing the deadlines for submission of the bids by the bidders, opening of bids etc. The bidders should follow this time during bid submission.
6. All the documents being submitted by the bidders would be encrypted using PKI encryption techniques to ensure the secrecy of the data. The data entered cannot be viewed by unauthorized persons until the time of bid opening. The confidentiality of the bids is maintained using the secured Socket Layer 128-bit encryption technology. Data storage encryption of sensitive fields is done.
7. The uploaded tender documents become readable only after the tender opening by the authorized bid openers.
8. Upon the successful and timely submission of bids, the portal will give a successful bid submission message & a bid summary will be displayed with the bid no. and the date & time of submission of the bid with all other relevant details.
9. Add scanned PDF of all relevant documents in a single PDF file of compliance sheet.

### **2.2.5 Assistance to bidders**

1. Any queries relating to tender document and the terms and conditions contained therein should be addressed to the tender inviting authority for a tender or the relevant contact person indicated in the tender.
2. Any queries relating to the process of online bid submission or queries relating to CPP portal in general may be directed to the 24 x 7 CPP Portal Help Desk.

### **2.2.6 General instruction to bidders**

1. The tenders will be received online through portal <https://eprocure.gov.in/eprocure/app>. In the technical bids, the bidders are required to upload all the documents in PDF format.
2. Possession of a valid class II / III Digital Signature Certificate (DSC) in the form of smart card / e-token in the company's name is a prerequisite for registration and participating in the bid submission activities through <https://eprocure.gov.in/eprocure/app>. Digital Signature Certificates can be obtained from the authorized certifying agencies, details of which are available in the website <https://eprocure.gov.in/eprocure/app> under the link "Information about DSC".

Tenderers are advised to follow the instructions provided in the "Instructions to the tenderer" for the e-submission of the bids online through the Central Public Procurement Portal for e-procurement at <https://eprocure.gov.in/eprocure/app>.

Dean, Infrastructure and Planning  
Indian Institute of Technology Kanpur

## **2.3 List of documents to be scanned and uploaded within the period of bid submission**

The following mandatory documents to be submitted with online bid submission:

The Online bids (complete in all respect) must be uploaded online in two Envelops as explained here: -

### **2.3.1 Envelope - 1: Technical Bid**

The following mandatory documents to be provided as **a single PDF** file in the same sequence as listed for evaluation:

1. EMD Declaration [as per 6.1](#)
2. Proof of submission of Processing Fees [as per 6.2](#)
3. GST Registration Certificate or GST Undertaking [as per 6.3](#)
4. EPF & ESI Registration
5. Copy of PAN card
6. Turnover and Other Financial statement of the Agency [as per 6.5](#)
7. Affidavit for not being blacklisted/debarred/restrained [As per 6.4](#)
8. Solvency certificate [as per 6.6](#) **Or** Net Worth Certificate from certified Chartered Accountant [as per 6.7](#)
9. Performance report of works executed [as per 6.8](#)
10. Structure and Organization of the Agency [as per 6.9](#)
11. Declaration on Details of the Bidder(s) [as per 6.10](#)
12. Details of Similar Nature of Works Completed [as per 6.11](#)
13. Declaration about Site Inspection [as per 6.12](#)
14. Letter of Transmittal [as per 6.13](#)

### **2.3.2 Envelope - 2: Financial Bid**

Price bid should be submitted in BOQ format

### 3 Eligibility Criteria

#### 3.1 Eligibility criteria for contractors

Contractors who fulfill the following criteria shall be eligible to apply.

##### Eligible Bidders

Eligible bidders should satisfy the following criteria for an eligible bid:

1. **Average annual financial turn over:**

Average annual financial turnover of Building & Road works should be at least 30% of the estimated cost of work put to tender during the last 3 consecutive financial years by the certified Chartered Accountant.

Audited turnover statements to be furnished as proof of the same duly certified by chartered accountant along with Profit & Loss Statements.

The bidder should not have incurred loss (profit after tax should be positive) in more than two years during last five financial years ending **31st March 2023**, duly audited and certified by the Chartered Accountant.

Solvency Certificate- 30% of the estimated cost put to tender **Or** Net Worth Certificate from certified Chartered Accountant **as per 6.7**

2. **Experience (value of work done shall be within a span of one year):**

Firms/Contractors must have completed satisfactorily

i) One similar work of 80% value of the estimated cost put to tender

Or

ii) Two similar work of 60% value of the estimated cost put to tender

or

iii) Three similar work of 40% value of the estimated cost put to tender

Works completed during last 7 years ending on date **31.03.2023**.

**AND**

One work of similar nature (either part of (i) or a separate one) with Cement Grouted Bituminous Concrete technology, costing not less than the amount equal to 40% of the Estimated cost put to tender with Central Government Organization/Central Autonomous Body/Central Public Sector undertakings/ State Government Establishment.

3. **Definition of similar work:** Similar type of work means “**Construction/ Maintenance/ Resurfacing work for bituminous roads**” done with any Central Government Department / Central Autonomous Body / Central Public Sector Undertakings /State Government Establishment of repute in last 7 years (Not earlier than **01-04-2016**).

**Eligible bidders must also satisfy the following conditions and ensure submission of all documents mentioned in 2.3**

1. **Legal:** Unregistered Partnership Firm and Joint Venture or Consortium are not eligible.
2. **Registration:** Bidder should be registered with the Income Tax Department, Employees Provident Fund (EPF) Organization, Employees State Insurance (ESI) Corporation &

GST. Bidders are not eligible in absence of these documents.

**3. Office:**

Bidders have to establish its local accessible office registered with local GSTIN at IIT Kanpur to run the awarded work.

## 4 Bid Evaluation

The following process will be followed for the Technical and Financial Bids Evaluation:

### 4.1 Technical Bid Evaluation

- Technical bids received complete in all respects covering the entire scope of work, will only be opened
- The technical bid evaluation is done only for bidders who satisfy the minimum criteria by submitting documentary proof supporting eligibility criteria and the bids of agencies who have not submitted these documents are liable to be rejected without notice
- **Marking scheme:** Maximum marks = 100, **Bidders obtaining more than or equal to 75 marks will be technically qualified**

#### Marking Scheme

1.	<b>Completion certificate for Similar works within the span of last <b>seven years</b></b>	:	Max Marks = 25
(a)	One similar work of 80% value / (a) Two similar works of 50% value/ Three similar works of 40% value of the estimated cost put to tender	:	10 Marks
(b)	Two similar works of 80% value / (a) Three similar works of 50% value/ Four similar works of 40% value of the estimated cost put to tender	:	20 Marks
(c)	Three similar works of 80% value / (a) Four or more similar works of 50% value/ Five or more similar works of 40% value of the estimated cost put to tender	:	25 Marks
2.	<b>Average turn over in crore of the organization in last <b>three financial years</b></b>	:	Max Marks = 25
(a)	Turnover more than 100% – 200%	:	10 Marks
(b)	Turnover more than 200% – 300%	:	20 Marks
(c)	Turnover more than 300%	:	25 Marks
3.	<b>Performance Report</b>	:	Max Marks = 25
(a)	Outstanding	:	25 Marks
(b)	Very good	:	20 Marks
(c)	Good/Satisfactory	:	15 Marks
(d)	Poor	:	5 Marks

4. **Technical presentation - Presentation by Bidders shall be held on the day of opening the Technical Bid unless otherwise informed in CPP portal. The venue & and time shall be informed in CPP portal** : Max Marks = 25

---

(a) Implementation strategy of the contract proposed by the agency for executing the work on timely basis and addressing the deployment of resources, time and progress strategies and the expertise financially and technically to do the work highlighting the experience of CGBC Technology, needs to be incorporated. : 25 Marks

---

(a)	Excellent	:	> 20 Marks
(b)	Good	:	16-20 Marks
(c)	Average	:	11-15 Marks
(d)	Fair	:	6-10 Marks
(e)	Poor	:	= 5 Marks

---

## 4.2 Financial Bid Evaluation

For financial bids, the following points shall be followed:

- Only the bidders securing minimum of 75 marks out of 100 marks in technical evaluation qualifies for subsequent opening of financial bid
- Weightage for total marks obtained by bidder in technical bid shall be 30% technical weightage and financial bid shall be 70% financial weightage. Thereby, total 100% weightage for the complete bid. **For example: If a bidder secures 90 marks out of 100 marks in technical evaluation, his technical weightage will be 27 marks.**
- Bidder with lowest financial bid: 100 Marks. Financial weightage is 70%. **For example: The financial weightage of the bidder with lowest financial bid will be 70 Marks and the higher bids will be evaluated accordingly.**

### NOTE

The employer reserves the right, without being liable for any damages or obligation to inform the bidder, to:

- Amend the scope and value of contract to the bidder.
- Reject any or all the applications without assigning any reason.

Any effort on the part of the bidder or his agent to exercise influence or to pressurize the employer would result in rejection of his bid. Canvassing of any kind is prohibited.

## 5 Integrity Pacts

### INTEGRITY AGREEMENT

(To be executed on a non-judicial Stamp Paper of Rs.100 and applicable for all tenders of threshold value above Rs. 1 Crore)

This INTEGRITY PACT is made and executed at.....  
on this day of....., 2023

BY AND BETWEEN

The Indian Institute of Technology Kanpur represented through Dean, Infrastructure and Planning, having its office located at GT Road, Kalyanpur, Kanpur, Uttar Pradesh - 208016 (hereinafter referred to as "**The Principal**" which terms or expression shall, unless excluded by or repugnant to the subject or context, mean and include its successor-in-office, administrators or permitted assignees) of the **First Part**;

AND

M/s.....a company incorporated under the Companies act,.....  
through its representative /authorized signatory (insert name and designation of the officer) vide resolution dated..... passed by the board of directors, having its office at .....( hereinafter referred to as "**The Bidder/Contractor**" which terms or expression shall, unless excluded by or repugnant to the subject or context, mean and include its successor-in-office, administrators or permitted assignees) of the **Second Part**;

#### Preamble

The principal intends to award, under laid down organizational procedures, contract/s for [Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus](#). The principal values full compliance with all relevant laws of the land, rules, regulations, economic use of resources and of fairness/transparency in its relations with its Bidder(s) and/or Contractor(s). In order to achieve these goals, the Principal will appoint Independent External Monitors (IEMs), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

#### 5.1 Section 1: Commitments of the Principal

- 1) The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:
  - a. No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
  - b. The Principal will during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential/ additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.
  - c. The Principal will exclude from the process all known prejudiced persons.

- 2) If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the IPC/PC Act, or if there be a substantive suspicion in this regard, the Principal will inform the Chief Vigilance Officer and in addition can initiate disciplinary actions.

## **5.2 Section 2: Commitments of the Bidder(s)/Contractor(s)**

- 1) The Bidder(s)/Contractor(s) commit themselves to take all measures necessary to prevent corruption. The Bidder(s)/Contractor(s) commits themselves to observe the following principles during participation in the tender process and during the contract execution.
  - a. The Bidder(s)/Contractor(s) will not, directly or through any other persons or firm, offer, promise or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material or other benefit which he/she is not legally entitled to, in order to obtain in exchange any advantage or any kind whatsoever during the tender process or during the execution of the contract.
  - b. The Bidder(s)/Contractor(s) will not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.
  - c. The Bidder(s)/Contractor(s) will not commit any offence under the relevant IPC/PC Act; further the Bidder(s)/Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to other, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.
  - d. The Bidder(s)/Contractor(s) of foreign origin shall disclose the name and address of the Agents/representatives in India, if any. Similarly, the Bidder(s)/Contractor(s) of Indian Nationality shall furnish the name and address of the foreign principals, if any. Further details as mentioned in the "Guidelines of Indian Agents of Foreign suppliers" shall be disclosed by the Bidders(s)/Contractor(s). Further, as mentioned in the Guidelines all payments made to the Indian Agent/representative have to be in Indian Rupees only. Copy of the "Guidelines on Indian Agents of Foreign Suppliers" as annexed and marked as Annexure-A.
  - e. The Bidder(s)/Contractor(s) will, when presenting their bid, disclose any and all payments made, is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
  - f. Bidder(s)/Contractor(s) who have signed the Integrity Pact shall not approach the courts while representing the matter to IEMs and shall wait for their decision in the matter.
- 2) The Bidder(s)/Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

### **5.3 Section 3: Disqualification from tender process and exclusion from future contracts**

If the Bidder(s)/Contractor(s), before award or during execution has committed a transgression through a violation of Section 2, above or in any other form such as to put their reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/Contractor(s) from the tender process or take action as per the procedure mentioned in the "Guidelines on Banning of business dealing". Copy of the "Guidelines on Banning of business dealing" is annexed and marked as Annexure-B.

### **5.4 Section 4: Compensation for Damages**

1. If the Principal has disqualified the Bidder(s) from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/Bid Security.
2. If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages of the Contract value or the amount equivalent to Performance Bank Guarantee.

### **5.5 Section 5: Previous Transgression**

1. The Bidder declares that no previous transgressions occurred in the last three years with any other company in any country conforming to the anti-corruption approach or with any public sector enterprise in India that could justify his exclusion from the tender process.
2. If the bidder makes incorrect statement on this subject, he can be disqualified from the tender process or action can be taken as per the procedure mentioned in "Guidelines on Banning of business dealing".

### **5.6 Section 6: Equal treatment of all Bidders / Contractors / Sub-Contractors**

- 1) In case of sub-contracting, the Principal Contractor shall take the responsibility of adoption of Integrity Pact by the Sub-contractor.
- 2) The Principal will enter into agreements with the identical conditions as this one with all bidders and Contractors.
- 3) The Principal will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

### **5.7 Section 7: Criminal charges against violating Bidder(s) / Contractor(s) / Sub-contractors(s)**

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the same to the Chief Vigilance Officer.

## **5.8 Section 8: Independent External Monitor**

1. The Principal appoints competent and credible Independent External Monitor for this Pact after approval by Central Vigilance Commission. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.
2. The Monitor is not subject to instructions by the representatives of the parties and performs his/ her functions neutrally and independently. The Monitor would have access to all contract documents, whenever required. It will be obligatory for him/her to treat the information and documents of bidders /contractors as confidential. He/she reports to the Director, IIT Kanpur.
3. The Bidder(s)/Contractor(s) accepts that the Monitor has the right to access without restriction to all project documentation of the Principal including that provided by the Contractor. The Contractor will also grant the Monitor, upon his/her request and demonstration of a valid interest, unrestricted and unconditional access to their project documentation. The same is applicable to Subcontractors.
4. The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/Contractor(s)/Subcontractor(s) with confidentiality. The Monitor has also signed declarations on "Non - Disclosure of Confidential Information" and of "Absence of Conflict of Interest" In case of any conflict of interest arising at a later date, the IEM shall inform the Director, IIT Kanpur.
5. The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.
6. As soon as the Monitor notices, or believes to notice, a violation of this agreement, he/she will so inform the Management of the Principal and request the Management to discontinue or take corrective action, or to take other relevant action. The monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action.
7. The Monitor will submit a written report to the Director, IIT Kanpur within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.
8. If the Monitor has reported to the Director, IIT Kanpur, a substantiated suspicion of an offence under relevant IPC/PC Act, and the Director, IIT Kanpur has not, within the reasonable time taken visible action to proceed against such offence or reported it to the Chief Vigilance Officer, the Monitor may also transmit this information directly to the Central Vigilance Commissioner.
9. The word "Monitor" word include both singular and plural.

## **5.9 Section 9: Pact Duration**

This pact begins when both parties have legally signed it. It expires for the Contractor 12 months after the last payment under the contract, and for all other Bidders 6 months after the contract has been awarded. Any violation of the same would entail disqualification of the bidders and exclusion from future business dealing.

If any claim is made/lodged during the time, the same shall be binding and continue to be valid despite the lapse of this Pacts as specified above, unless it is discharged/determined by the Competent Authority.

**5.10 Section 10: Other Provisions**

- 1) This agreement is subject to Indian Law, Place of performance and jurisdiction is the Office of the Director, IIT Kanpur.
- 2) Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.
- 3) If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.
- 4) Should one or several provisions of this Pact turn out to be invalid, the remainder of this Pact remains valid. In this case, the parties will strive to come to an agreement to their original intentions.
- 5) Issues like Warranty/Guarantee etc. shall be outside the purview of the IEMs.
- 6) In the event of any contradiction between the Integrity Pact and its Annexure, the clause in the Integrity Pact will prevail.
- 7) The actions stipulated in this Integrity Pact are without prejudice to any other legal action(s) that may follow in accordance with the provisions of the extent law in force relating to any civil or criminal proceedings.

.....  
(For and on behalf of IIT Kanpur)

.....  
(For and on behalf of Bidder/Contractor)

(Office Seal)

(Office Seal)

WITNESSES:

1. ....  
(Signature, name and address)

2. ....  
(Signature, name and address)

Place:.....

Date: ..... \ ..... \ 20.....

## 6 Various Forms and Formats

### 6.1 Declaration in lieu of submitting Earnest Money Deposit

**Proforma for Declaration in lieu of submitting Earnest Money Deposit**  
(Scanned copy of this Declaration to be uploaded at the time of submission of bid)

Whereas, I/we ..... (name of agency) have submitted bids for Name of work: - “Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus”.

I/we hereby submit following declaration in lieu of submitting Earnest Money Deposit:

1. If after the opening of tender, I/we withdraw or modify my/our bid during the period of validity of tender (including extended validity of tender) specified in the tender documents,  
or
2. If, after the award of work, I/we fail to sign the contract, or to submit performance guarantee before the deadline defined in the tender documents,

I/we shall be suspended for **two year** and shall not be eligible to bid for IITK tenders from date of issue of suspension order.

.....  
Signature of the Bidder(s)

## 6.2 Format for submission of processing fees

**Format for proof of submission to be uploaded along with transaction slip**  
(Scanned copy of this page to be uploaded at the time of submission of bid)

I/we have submitted the processing fees as per the following details:

NIT No	:	Civil/27/02/2024-1
Name of Agency	:	
GST number of Agency	:	
Date of transaction	:	
Total amount transferred	:	
UTR number	:	

.....  
Signature of the Bidder(s)

Details of Institute Account for submitting processing fees are as follows:

Beneficiary Name: The Registrar, IIT Kanpur  
Bank Name: SBI, IIT Kanpur  
Account Number: 30632766814  
IFSC Code: SBIN0001161

### 6.3 Undertaking regarding obtaining GST registration

**Proforma for Undertaking regarding obtaining GST registration Certificate of The State in which work is to be taken up**

(Undertaking to be furnished on a 'Non-Judicial' stamp paper worth Rs.100/)

(Scanned copy of this notarized undertaking to be uploaded at the time of submission of bid, if required)

If work is awarded to me, I/we shall obtain GST registration Certificate of the State, in which work is to be taken up within one month from the date of receipt of award letter or before release of any payment by IITK, whichever is earlier, failing which I/We shall be responsible for any delay in payments which will be due towards me/us on a/c of the work executed and/or for any action taken by IITK or GST department in this regard.

.....  
(Signature of Bidder(s))

**Or**

.....  
(An authorized Officer of the firm with stamp)

.....  
(Signature of Notary with seal)

#### 6.4 Affidavit for not being blacklisted/debarred/restrained

**Proforma for AFFIDAVIT for not being blacklisted/debarred/restrained**

(AFFIDAVIT to be submitted on a 'Non-Judicial' stamp paper worth Rs.100/)

(Scanned copy of this notarized affidavit to be uploaded at the time of submission of bid)

I/we undertake and confirm that our firm/partnership firm has not been blacklisted and/or debarred/restrained by ny Central Govt./ State Govt. Agency/ Autonomous body of the Central or State govt./ PSU etc. Further that, if such information comes to the notice of the Institute, then I/we shall be debarred for bidding in the Institute in future forever. Also, if such information comes to the notice of the Institute on any day before date of start of work, the competent authority shall be free to cancel the agreement and to forfeit the entire amount of Earnest Money Deposit/Performance Guarantee.

.....  
(Signature of Bidder(s))

**Or**

.....  
(An authorized Officer of the firm with stamp)

.....  
(Signature of Notary with seal)

## 6.5 Financial Information

### Proforma for providing Financial Information

(Scanned copy of the completed information sheet to be uploaded at the time of submission of bid)

Financial Analysis: Details to be furnished duly supported by figures in balance sheet/ profit & loss account for the last three financial years duly certified by the Chartered Accountant, as submitted by the applicant to the Income Tax Department (Copies to be attached).

Financial Years	2019	2020	2021	2022
Gross Annual turnover				
Profit/Loss				

.....  
Signature of Chartered Accountant with Seal

.....  
Signature of the bidders(s)

## 6.6 Banker's Certificate from a scheduled Bank

### Proforma of Banker's Certificate from a Scheduled Bank

(To be printed in Bank's Letterhead)

(Scanned copy of the Certificate to be uploaded at the time of submission of bid)

This is to certify that to the best of our knowledge and information that M/s./Sh.....  
having marginally noted address, a customer of our bank are/is respectable and can be treated  
as good for any engagement up to a limit of Rs ..... (Rupees ..... ). This  
certificate is issued without any guarantee or responsibility on the bank or any of the officers.

.....  
(Signature for the Bank)

#### NOTE:

1. Bankers certificates should be on letter head of the Bank, addressed to tendering authority.
2. In case of partnership firm, certificate should include names of all partners as recorded with the Bank.

## 6.7 Net Worth Certificate by certified Chartered Accountant

### Proforma of Net Worth Certificate by certified Chartered Accountant

(To be printed in Letterhead of Chartered Accountant)

(Scanned copy of the Certificate to be uploaded at the time of submission of bid)

This is to certify that as per the audited Balance Sheet and Profit & Loss statement of the account during the financial year ....., the net worth of M/s./Sh.....(Name & Registered Address of individual/firm/company) as on 31.3.2023 is Rs. .... (Rupees. ....) after considering all liabilities.. It is further certified that the net worth of the company has not eroded by more than 30% in the last three years ending on 31.3.2023.

.....  
(Signature of the Chartered Accountant)

.....  
(Name of the Chartered Accountant)

.....  
(Membership No. of ICAI)

.....  
(Date & Seal)

## 6.8 Performance report on work executed

### **Proforma of Performance report on works referred to in Financial Information**

(To be printed in Company's Letterhead)

(Scanned copy of the Performance Reports to be uploaded at the time of submission of bid)

1. Name of work/project & location:
2. Agreement no.:
3. Estimated cost:
4. Tendered cost:
5. Date of start:
6. Date of completion:
7. Stipulated date of completion:
8. Actual date of completion:
9. Amount of compensation levied for delayed completion, if any:
10. Amount of reduced rate items, if any:
11. Performance Report:
  - (a) Quality of work: Outstanding / Very Good / Good /Poor
  - (b) Technical Proficiency: Outstanding / Very Good / Good /Poor
  - (c) Resourcefulness: Outstanding / Very Good / Good /Poor
  - (d) General Behavior: Outstanding / Very Good / Good /Poor

Date:

Signature of Superintending Engineer or Equivalent

## 6.9 Structure and Organization of the Agency

### **Proforma of providing Structure and Organization of the Bidding Agency**

(To be printed in Company's Letterhead)

(Scanned copy of the Structure and Organization Document to be uploaded at the time of submission of bid)

1. Name & address of the bidder:
2. Telephone no./Telex no./Fax no.:
3. Email address for Communication.:
4. Legal status of the bidder (attach copies of original document defining the legal status):
  - (a) An Individual:
  - (b) A proprietary firm:
  - (c) A firm in partnership:
  - (d) A limited company or Corporation:
5. Particulars of registration with various Government Bodies (attach attested photocopy)  
**Organization / Place of registration Registration No.**
  - 1.
  - 2.
  - 3.
6. Names and titles of Directors & Officers with designation to be concerned with this work.
7. Designation of individuals authorized to act for the organization
8. Has the bidder, or any constituent partner in case of partnership firm, ever been convicted by the court of law? If so, give details.
9. Any other information considered necessary but not included above.

(Signature of of Bidder(s))

## 6.10 Declaration on Details of the Bidders

### Proforma of Declaration on Details of the Bidders

(To be printed in Company's Letterhead)

(Scanned copy of the Performance Reports to be uploaded at the time of submission of bid)

#### DECLARATION

I/We, .....hereby declare that all the information and data furnished by our organization with regard to this tender specification are true and complete to the best of our knowledge. I/we have gone through the specification, conditions and stipulations in details and agree to comply with the requirements and intent of specification.

Particulars of the bidder as per following details:

1	Name of the firm / organization	:	
2	Type of the firm / organization: Public Ltd. / Private Ltd. / Registered firm	:	
3	Registered address	:	
4	Address of office	:	
5	Contact people	:	
6	Name & Designation	:	
7	Landline & Mobile numbers	:	
8	E-mail IDs	:	
9	PAN No.	:	
10	GST No.	:	
11	EPFO Reg. No.	:	
12	ESIC Reg. No.	:	
13	Annual Turnover for the last 3 years (Enclose copies of audited balance sheet and P&L A/c.)	:	
13.1	2021-2022	:	
13.2	2020-2021	:	
13.3	2019-2020	:	
14	EMD Declaration attached with signature	:	
15	Has the applicant ever been required to suspend any project for a period of more than six months continuously after Commencement of work?	:	If so, give the name of the project and reasons of suspension of project

16	Has the applicant ever been convicted by a court of law?	:	YES / NO, If yes, give details of the case
17	Details of any litigation in which the applicant is/was involved.	:	
18	All forms submitted as desired in the bid	:	Yes / No
19	Integrity Pact	:	
20	Undertaking regarding no subletting of work	:	

We further declare that our organization has not been blacklisted /delisted or put to any holiday by any Institutional agency / Govt. Department / Public Sector Undertaking in the last three years.

Date:

Signature of Bidder(s) with seal

## 6.11 Details of Similar Nature of Works Completed

### Proforma for submission of Details of Eligible Similar Nature of Works Completed\* during the Last Seven Years ending previous day of the last date of submission of tenders

The bidding capacity of the contractor should be equal to, or more than the estimated cost of the work put to tender. The bidding capacity shall be worked out by the following formula: Bidding Capacity =  $[A \times N \times 1.5] - B$ , where

$A$  = Maximum turnover in construction works executed in any one year during the last seven years taking into account the completed as well as works in progress. The value of completed works shall be brought to current costing level by enhancing at a simple rate of  $7N$  = Number of years prescribed for completion of work for which bids has been invited.  $B$  = Value of existing commitments and ongoing works to be completed during the period of completion of work for which bids have been invited.

The contractor needs to submit the supporting documents in the following tabular format:

Sr.No	Name of work/project and location	Owner or sponsoring organization	Cost of work in crores of rupees	Date of commencement as per contract	Stipulated date of completion	Actual date of completion	Litigation / arbitration cases pending / in progress with details*	Name and address/ telephone number of whom reference maybe made	Whether the work was done on back to back basis Yes / No
1	2	3	4	5	6	7	8	9	10

\* Indicate gross amount claimed and amount awarded by the Arbitrator.

Date:

Signature(s) of Bidder with seal

## 6.12 Declaration About Site Inspection

### Declaration about Site Inspection

(By Bidder)

To

The Dean Infrastructure and Planning

Subject: Submission of Tender for the work of “[Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus](#)”.

Dear Sir/Madam,

It is hereby declared that as per terms and conditions of this tender document, I/ We the bidder inspected and examined the subject site and its surrounding and satisfy myself / ourselves as to the nature of the ground and sub-soil (so far as is practicable), the forms and nature of the site./ ourselves before submitting the bid, the accommodation which may require and all necessary information as to risks, contingencies and other circumstances which may influence or affect our bid have been obtained. I/We the bidder shall have full knowledge of the site and no extra charge consequent upon any misunderstanding or otherwise shall be claimed in later date. I /We bidder shall be responsible for arranging and maintaining at own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by me/us implies that I / We have read this notice and all other contract documents and has made myself /ourselves aware of the scope and specifications of the work to be done and local conditions and other factors having a bearing on the execution of the work.

Sincerely

(Duly authorized signatory of the Bidder)

### 6.13 Letter of Transmittal

To

The Dean, Infrastructure and Planning  
Indian Institute of Technology Kanpur  
Kanpur, UP - 208016

Name of Work: [Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus](#)

Dear Sir/Madam

Having examined details given in Notice and bid document for the above work, I/we hereby submit the relevant information.

1. I/We hereby certify that all the statements made and information supplied in the enclosed forms and accompanying statement are true and correct.
2. I/we have furnished all information and details necessary for eligibility and have no further pertinent information to supply.
3. I/We also authorize the Dean, Infrastructure and Planning, Indian Institute of Technology Kanpur or his representative(s) to approach individuals, employers, firms and corporation to verify our competence, work experience, and general reputation.
4. I/we submit the following certificates in support of our suitability, technical knowledge and capability for having successfully completed the following eligible completed works:

Sl. No.	Name of work	Amount	Certificate issued by
1.			
2.			
3.			
4.			

#### CERTIFICATE

It is certified that the information given in the enclosed eligibility bid are correct. It is also certified that I/We shall be liable to be debarred, disqualified/ cancelation of enlistment in case any information furnished by me/us found to be incorrect.

Enclosures:

Date of submission:

Signature(s) of Bidder with seal

## 6.14 CPWD-7

### CPWD-7

#### PERCENTAGE RATE TENDER & CONTRACT FOR WORKS

Tender for the “[Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus](#)”

1. To be uploaded as per details uploaded in CPP portal at [www.eprocure.gov](http://www.eprocure.gov)
2. To be opened in the presence of tenderers who may be present at the time of opening in the Dean, Infrastructure and Planning, IIT Kanpur.
3. The pre-qualification/Technical bid shall be opened first on due date and time as mentioned above. The time and date of opening of financial bid of contractors qualifying the technical bid shall be communicated to them at a later date.

#### TENDER

[\(\(To be signed in Company's Letterhead\)\)](#)

I/We have read and examined the notice inviting tender, schedule, A, B, C, D, E & F Specifications applicable, Drawings & Designs, General Rules and Directions, Conditions of Contract, clauses of contract, Special conditions, Schedule of Rate & other documents and Rules referred to in the conditions of contract and all other contents in the tender document for the work.

I/We hereby tender for the execution of the work specified for the Board of Governors within the time specified in Schedule 'F' viz., schedule of quantities and in accordance in all respect with the specifications, designs, drawing and instructions in writing referred to in Rule-1 of General Rules and Directions and in Clause 11 of the Conditions of contract and with such materials as are provided for, by, and in respect of accordance with, such conditions so far as applicable.

We agree to keep the tender open for [Ninety \(90\) days](#) from the due date of its opening and not to make any modification in its terms and conditions.

In lieu of EMD, I/We hereby submit Earnest Money Deposit (EMD) Declaration as per [6.1](#)

If I/We, fail to furnish the prescribed performance guarantee within prescribed period, I/We agree that the said Board of Governors or his successors, in office shall without prejudice to any other right or remedy, be at liberty to take action as per my/our EMD declaration as per [6.1](#). Further, if I/We fail to commence work as specified, I/We agree that Board of Governors or the successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said performance guarantee absolutely. The said Performance Guarantee shall be a guarantee to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to those in excess of that limit at the rates to be determined in accordance with the provision contained in Clauses 12.2 and 12.3 of the tender form.

Further, I/We agree that in case of myself / our self-becoming liable for action as per my/our EMD declaration or forfeiture of Performance Guarantee as aforesaid, I/We shall be debarred for participation in the re-tendering process of the work.

**I/We undertake and confirm that eligible similar work(s) has/have not been got executed through another contractor on back-to-back basis. Further that, if such a violation comes to the notice of Department, then I/we shall be debarred for**

**tendering in Indian Institute of Technology Kanpur in future forever. Also, if such a violation comes to the notice of Indian Institute of Technology Kanpur before date of start of work, the Dean, Infrastructure and Planning shall be free to forfeit the entire amount of Performance Guarantee.**

I/We hereby declare that I/We shall treat the tender documents drawings and other records connected with the work as secret/confidential documents and shall not communicate information/derived there from to any person other than a person to whom I/We am/are authorized to communicate the same or use the information in any manner prejudicial to the safety & integrity of IIT Kanpur

Dated:

Signature(s) of Contractor(s) with seal

Postal Address:

Witness:

Address:

Occupation:

## 7 Proforma of Schedules

### PROFORMA OF SCHEDULES (Tender)

#### 7.1 SCHEDULE 'A': Schedule of Quantities

Schedule of Quantities : BOQ uploaded separately

#### 7.2 SCHEDULE 'B': Schedule of materials to be issued to the contractor

Schedule of materials to be issued to the contractor: NIL

#### 7.3 SCHEDULE 'C': Tools and plants to be hired to the contractor

Tools and plants to be hired to the contractor: NIL

#### 7.4 SCHEDULE 'D': Extra schedule for specific requirements/document for the work, if any

Extra schedule for specific requirements/document for the work, if any: NIL

#### 7.5 SCHEDULE 'E': Reference to General Conditions of contract

Reference to General Conditions of contract	:	General Conditions of Contract 2023 for Construction Works & Maintenance work and as amended / modified up to the last date of submission of Bid.
Name of Work	:	“Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus”
Total Estimated cost of work	:	Rs. 1,10,39,946/-
Earnest Money	:	EMD declaration to be submitted
Performance Guarantee	:	5% of tendered value valid upto stipulated date of completion and six (6) months beyond that
Security Deposit	:	5% of tendered value will be deducted from each bill. 2.50% will be released after 2.50 years of successful completion of the work and the remaining will be released after completion of Five (5) years defect liability period and as mentioned in special conditions of the contract.

#### 7.6 SCHEDULE 'F': General Rules and Directions

GENERAL RULES & DIRECTIONS:

Officer Inviting tender: Dean, Infrastructure and Planning

### 7.6.1 Definitions

1 Inviting Authority	:	Dean, Infrastructure and Planning
2(v) Engineer-in-Charge: For Civil Items of Work	:	Engineer Authorized by Dean, Infrastructure and Planning
2(viii) Accepting Authority	:	Director
2(x) Percentage on cost of materials and Labour to cover all overheads and profits	:	15%
2(xi) Standard Schedule of Rates	:	For Civil work: DSR 2021 (Civil Works) & MR with correction slips up to the last date of Bid
2(xii) Department	:	Infrastructure and Planning, IIT Kanpur
9(ii) Standard CPWD Contract Form	:	General Conditions of Contract 2023 for Construction Works & Maintenance work and as amended / modified up to the last date of submission of Bid.

### 7.6.2 Clauses

<b>Clause 1</b>	
Time allowed for submission of Performance Guarantee, Programme Chart (Time and Progress) and applicable labour licenses, registration with EPFO, ESIC and BOCW welfare board or proof of applying thereof from the date of issue of the letter of acceptance	: <b>7 days</b>
Maximum allowable extension with late fee @ 0.1% per day of Performance Guarantee amount beyond the Period provided in (i) above	: <b>7 days</b>
<b>Clause 1A</b>	: <b>Applicable. The Defect liability period shall be <b>Five (5) years</b> from the date of handing over of the assigned <b>works to the user/Institute</b></b>
<b>Clause 2</b>	

Authority for fixing compensation under Clause 2	:	Dy. Director/Director, IIT Kanpur
<b>Clause 2A</b>		
Whether Clause 2A shall be applicable	:	YES
<b>Clause 5</b>	:	
(i): Number of days from the date of issue of letter of acceptance for reckoning date of start	:	15 Days
ii: Milestones	:	As per Table 7
<b>Clause 6: Computerized Measurement Bill</b>	:	<i>Applicable</i>
<b>Clause 7</b>	:	Applicable
<b>Clause 10A</b>	:	Applicable
<b>Clause 10B (ii)</b>	:	Not Applicable
<b>Clause 10B (iii)</b>	:	Not Applicable
<b>Clause 10C</b>	:	<i>Not Applicable</i>
<b>Clause 10CA</b>	:	<i>Not Applicable</i>
<b>Clause 10CC</b>	:	Not applicable
<b>Clause 11</b>	:	CPWD Specifications of all Civil items (CPWD Civil specification vol.1 and vol.2, 2019), <b>MORTH specifications for road and bridge works (Fifth revision) 2013, IRC:SP:125-2019 &amp; IRC:44</b> with correction Slips issued up to the last date of receipt of tenders and as per <b>NIT for Civil and Road Works</b> .
<b>Clause 12: Type of work</b>	:	Original Work
<b>Clause 12.2 &amp; 12.3: Deviation limit beyond which clause 12.2 &amp; 12.3 shall apply for Building &amp; foundation work (except items mentioned in earth work in DSR and related items)</b>	:	30%
<b>Clause 16 Competent Authority for deciding reduced rates: For Civil items and For Electrical items of work</b>	:	<b>As per Table 8</b>
<b>Clause 17 - Defect liability period completion of contract whichever is later</b>	:	<b>Five (5) years and those listed in Special Conditions of Contract</b>

**Clause 18 - List of mandatory machinery, tools & plants to be deployed by the contractor at site** : As per Table 9 and those Listed in Special Conditions of Contract, if any

---

**Clause 32 - Requirement of Technical Representative(s)** : as per Table 11

---

*If the Contractor commits default in commencing the execution of the work as aforesaid, the performance guarantee shall be forfeited.*

Table 7: Major milestones of the project

Sl. No.	Description of Milestone (Physical)	Time allowed from date of start	Maximum Duration of work	Amount to be withheld in case of non-achievement of milestone (% of tendered amount)
1	Providing and laying of Cement Grouted Bituminous Concrete on existing bituminous roads in IIT Kanpur campus	12 weeks	12 weeks	5

The detailed program chart approved by the engineer-in-charge shall indicate how the resources will be deployed by the contractor to maintain desired progress and for the completion of the work within the specified period. If the submitted program is approved, the milestone shall be redefined accordingly by the [Dean, Infrastructure and Planning, Indian Institute of Technology Kanpur](#). The amount to be withheld in such a case, for non-achievement of milestone(s), shall remain unaltered i.e., 5% of tendered amount.

Time allowed for execution of work : Three (3) months

Table 8: Authority to decide

(i)	Extension of time (EOT)	:	Dy. Director/Director, IIT Kanpur
(ii)	Rescheduling of milestones	:	Dean, Infrastructure and Planning, IIT Kanpur
(iii)	Shifting of date of start in case of delay in handing over of site	:	Dean, Infrastructure and Planning, IIT Kanpur

Table 9: LIST OF MACHINERY, TOOLS & PLANTS TO BE DEPLOYED BY THE CONTRACTOR AT SITE AS & WHEN REQUIRED

Sl. No.	Name of Equipment	Numbers
<b>1</b>	<b>Equipment for Road work</b>	
a	Vibratory Road rollers	2 Nos.
c	Smooth wheel static roller	1 No.
d	Mechanical paver finisher fitted with electronic sensing device	1 No.
e	Hot Mix Plant fitted with centralized control panel and electronic load sensor of capacity 100-120 TPH equipped with computerized control for grading of aggregates, bitumen content, temperature control etc. at the point of manufacturing.	1 No.
f	Pan mixer	1 No.
g	Spreaders	1 No.
h	Mechanical cleaner using compressed air	1 No.
i	Fully/ Semi-automatic thermoplastic paint applicator machine	1 No.
j	Mechanical broom	1 No.
<b>2</b>	<b>Equipment for transportation</b>	
a	Tippers	5 Nos.
b	Trucks	5 Nos.
<b>3</b>	<b>Pneumatic equipment</b>	
a	Air compressors (diesel)	1 No.
b	Milling machine	1 No.
c	Pump (diesel)	1 No.
d	Pump (electric) (Desirable)	1 No.

Table 10: Materials for which all India Wholesale Price Index to be followed

Sl.No	Material covered under this clause	Nearest Materials (other than cement, reinforcement bars and the structural steel) for which All India Wholesale Price Index to be followed	Base Price (without GST) of Materials, covered under clause 10 CA
1	Portland Pozzolana Cement (PPC)/ Ordinary Pozzolana Cement	Nil	Nil
2	Steel for Reinforcement TMT Fe 500D Primary Manufacturer	Nil	Nil
3	Structural Steel (Primary producers)	Nil	Nil

Table 11: Requirement of Technical staff as per Clause 32

Sl. No.	Qualification	Number	Minimum Experience in Year	Designation	Rate at which recovery shall be made from the contractor in the event of not fulfilling provision of Clause 32
1	Graduate/ Diploma	1	5	Project Planning/ Construction/ Quality/ Billing Engineer (Civil)	Rs. 15000 (Rupees Fifteen Thousand only) per month, per person

Note 1: Assistant Engineers retired from Government services who are holding Diploma will be treated at par with Graduate Engineers. *Diploma holder with minimum 10 years relevant experience with a reputed construction co. can be treated at par with Graduate Engineers for the purpose of such deployment subject to the condition that such diploma holders should not exceed 50% of requirement of degree engineers.*

## 8 Scope of work

The scope is the construction of laying of surface layer for Cement Grouted Bituminous Mix (CGBM) over existing bituminous pavements in IIT Kanpur for approx. 5 km length at various locations as per the square meter area mentioned in BOQ.

The work has to be carried out as per specification and methodology laid out IRC: SP: 125.2019. for CGBM and other associated works as per applicable Latest guidelines in MoRTH/IRC/CPWD specifications.

All source materials, Mix Design for Cement Grouted Bituminous Mix (CGBM) and other mandatory test as listed in IRC: SP: 125.2019. must be carried out in IIT Kanpur Lab and submitted for approval before commencement of the work at site.

**Note: The scope of the works listed above is indicative only. For the details of the works, please refer to the BoQ and the work has to be done strictly as per the specifications in the BoQ and the particular specifications and conditions mentioned in the tender document.**

### 8.1 List of Preferred Makes for Road Works (as applicable)

Preferred makes of materials to be used in the work are as under. In case of non-availability of these makes, the Engineer-in-charge may allow use of alternative BIS makes of materials in the work. Non-BIS marked materials may be permitted by the Engineer-in-charge. This is a general list of makes. All makes applicable as per Schedule of Quantities must be as per the Institute preferred make.

**All materials - coarse aggregates, fine aggregates, grout which consists of cement, sand, fly-ash & silica fumes should conform MoRTH/ IRC specifications. If any quality issues are noticed, Engineer-in-Charge reserves the right to do relevant testing as per MoRTH/ IRC by taking core from the laid down bituminous surfaces and based on the results, it can be asked to redo the entire application or other remedial measures as suggested**

No.	Material description	Manufacturer / Brand Name
1	Cement (PPC/OPC)	ACC, Ultratech, Vikram, Shree Cement, Abuja, JK Cement, Century Cement, Jaypee Cement & Prism Cement.
2	Bitumen	IOCL, BPCL & HPCL
3	Thermoplastic Paint	Asian Paints, Prime Road, Indigo

केन्द्रीय लोक निर्माण विभाग  
कार्यालय ज्ञापन

No. DG/MAN/410

ISSUED BY AUTHORITY OF DIRECTOR GENERAL, CPWD

NIRMAN BHAWAN, NEW DELHI

DATED: 22.10.2021

**Subject: Addition of new Para 4.10.2 in CPWD Works Manual 2019 regarding testing charges to be borne by contractor.**

It has been noticed that following provisions are sometimes being made in the NITs / Agreements by the NIT approving authorities:

"The cost of test shall be borne by contractor/ department in the manner as below:

- By the contractor, if the result shows that material does not conform to the relevant codes/ specification.
- By the department, if the results show that the material conforms to relevant codes/ specification."

It has been decided by the competent authority that testing charges shall be borne by the contractor in all cases. Accordingly following new para is added in CPWD Works Manual -2019.

Existing Provision	Modified Provision
4.10 Preparation of NIT	4.10 Preparation of NIT
4.10.2 No Provision	4.10.2 Testing charges to be borne by contractor
	Following provision shall be incorporated by the NIT approving authority in the NIT:
	All expenditure to be incurred for testing of samples e.g. packaging, sealing, transportation, loading, unloading etc. including testing charges shall be borne by the contractor. The NIT shall have list of approved laboratories for testing as approved by ADG / SDG.

This issues with the approval of competent authority.

(वी.पी. साहू) 22/10/2021

अधीक्षण अभियंता(सी.एंड एम.)

e-file 9116587

Issued from file No. CSQ/CM/16(1)/2021

प्रतिलिपि: सभी केलोनिवि तथा लोनिवि दिल्ली के अधिकारियों को आवश्यक सूचना एवं कार्यवाही हेतु।(केलोनिवि वेबसाईट के माध्यम से).

Figure 1: Modified provisions in CPWD works manual 2019 regarding testing charges to be borne by contractor

## 9 Special Conditions of Contract

### 9.1 Timely Completion

1. The work included in this tender is urgent.
2. All work components must be started simultaneously and has to be delivered together or early within the given time schedule.
3. The contractor has to deploy the labor and supervisory staff in shifts to meet the targeted completion date. The work may be executed in extended shifts or two shifts.
4. Number of days from the date of issue of letter of acceptance for reckoning date of start shall be as per Schedule. *If the Contractor commits default in commencing the execution of the work as aforesaid, the performance guarantee shall be forfeited.*
5. The detailed program chart approved by the engineer-in-charge shall indicate how the resources will be deployed by the contractor to maintain desired progress and for the completion of the work within the specified period. If the submitted program is approved, the milestone shall be redefined accordingly by the Dean of Infrastructure and Planning, IITK. The amount to be withheld in such a case, for non-achievement of milestone(s), shall remain unaltered. Any delay in achieving the milestone must be compensated within the limitations of time imposed in the Contract document
6. The contractor shall procure the required materials in advance so that there is sufficient time for testing of the materials and approval of the same before use in the work, as required.

### 9.2 Rates

1. Unless otherwise provided in the schedule of quantities of the work the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the building (Exclusive of GST) and nothing extra shall be payable to him on this account.
2. The rates for all items of work shall, unless clearly specified otherwise, include cost of all labours, materials and other inputs involved in the execution of the item irrespective of whether they have been specifically mentioned in the tender document or not.
3. In case the same item (s) appear more than once in the schedule of work / BOQ under the same sub head or among the different subhead of works, the lowest rate quoted for that item (s) shall be considered for the particular item(s) wherever appeared in any part of BOQ / Schedule of works for the purpose of tender evaluation although web generated e-price bid may incorporate different quoted rate for same item(s) as per the quoting pattern of the tenderer. The tendered amount thus worked out shall be final & shall be binding on the contractor.
4. The rates quoted by the contractor will be deemed to be inclusive of any extra expenditure of this reason. The contractor has to increase the manpower or other tools etc. to do the work as per the quantum of work provided to him at his own expenses. Nothing shall be paid on this account.
5. The contractor shall provide at his own cost suitable weighing, surveying and leveling and measuring arrangements as may be necessary at site for checking. All such equipments shall be got calibrated in advance from laboratory, approved by the Engineer-in-Charge. Nothing extra shall be payable on this account.

6. Other agencies may also simultaneously execute and install the works and the contractor shall afford necessary facilities for the same. The contractor shall leave such recesses, holes, openings, trenches etc. as may be required for such related works (for which inserts, sleeves, brackets, conduits, base plates, clamps etc. shall be available as specified elsewhere in the contract) and the contractor shall fix the same at the time of casting of concrete, stone work and brick work, if required, and nothing extra shall be payable on this account.
7. All material shall only be brought at site as per program finalized with the Engineer-in-Charge. Any pre-delivery of the material not required for immediate consumption shall not be accepted and thus not paid for.
8. The rates quoted by the Contractor are deemed to be inclusive of site clearance, setting out work, profile, establishment of reference bench mark(s), taking spot levels, construction of all safety and protection devices, barriers, preparatory works, working during monsoon, working at all depths, height, lead, lift and location etc until / unless specified otherwise and any other incidental works required to complete this work. Nothing extra shall be payable on this account.

### **9.3 Quality and Workmanship**

1. The contractor shall be entirely responsible and answerable for all the works done by him regarding quality, adherence to the laid down specifications, terms and conditions, warranty/guarantee etc. and he shall be liable to bear any compensation that may be levied by the department under any of the clauses of the agreement.
2. The materials having ISI mark shall have precedence over the one conforming to IS Specifications.
3. The proposed buildings are Institute housing and quality of work is paramount importance. Contractor shall have to engage well experienced skilled labour and deploy modern T&P and other equipment to execute the work.
4. Samples of all materials and fittings to be used in the work in respect of brand manufacturer and quality shall be approved from the Engineer-in-Charge, well in advance of actual execution and shall be preserved till the completion of the work.
5. All materials used in the work shall be new and of good quality, conforming to the relevant specifications as per good engineering practice. All the materials proposed to be used in the work should be approved from Engineer in Charge before use in work.
6. Articles bearing BIS certifications mark shall only be used unless no manufacturer has got BIS/ISI mark for the particular material. Any material/fitting whose sample has not been approved in advance and any other unapproved material brought by the contractor shall be immediately removed as soon as directed. Where the make of any particular material is not specified in the Contract document, the material shall be supplied as per makes desired by the engineer-in-charge.
7. It will be the responsibility of the contractor / bidder to ensure use of genuine materials in the work. The department reserves the right to get (any / all materials / components) inspected by the manufacturer or their authorized representatives at any stage of the execution of work. If any of the materials, supplied and used in work is found spurious at any stage, then the department reserves the right to ask the contractor to replace it by

genuine one and make suitable recovery till it is done, even if any payment against that material is already made.

8. The contractor should get the make/TDS documents approved before procuring any material at site. The TDS/Make once approved shall not be changed without any valid recorded reasons. No material to be brought and used at site without the prior knowledge & approval of Engineer-in-Charge.
9. The department may ask for any valid document like manufacturer's test certificate, document for purchase of the material, document for import/shipment of imported materials etc. as deemed fit by the engineer-in-charge to ascertain genuinely of material supplied by/used in the work by the contractor. The contractor shall remain bound to submit all such documents to the department failing which payment may not be made or if already paid may be recovered/ withheld from subsequent running account payment.
10. All equipment and their components, and all the materials to be used in the work shall be suitable for the environmental conditions at the location of the work.
11. The contractor shall ensure quality control measures on different aspects of construction including materials, workmanship and correct construction methodologies to be adopted. He shall have to submit quality assurance programme within two weeks of the award of work. The quality assurance programme should include method statement for various items of work to be executed along with check lists to enforce quality control.
12. The contractor shall get the source of all other materials, not specified elsewhere in the document, approved from the Engineer-in-Charge. The contractor shall stick to the approved source unless it is absolutely unavoidable. Any change shall be done with the prior approval of the Engineer-in-Charge for which tests etc. shall be done by the contractor at his own cost. Similarly, the contractor shall submit brand/ make of various materials not specified in the agreement, to be used for the approval of the Engineer-in-Charge along with samples and once approved, he shall stick to it.
13. **Tests in Laboratories:** The contractor shall arrange carrying out of all tests required under the agreement through the laboratory as approved by the Engineer-in-Charge and shall bear all charges in connection therewith including fee for testing.

All source materials, Mix Design for Cement Grouted Bituminous Mix (CGBM) and other mandatory test as listed in IRC: SP: 125.2019. must be carried out in IIT Kanpur Lab and submitted for approval before commencement of the work at site.

14. Sample of materials fittings and other articles required for execution of work shall be got approved from the Engineer-in-Charge. Articles manufactured by companies of repute and approved by the Engineer-in-Charge shall only be used. Articles bearing BIS certification mark shall be used in case the above are not available, the quality of samples brought by the contractor shall be judged by standards laid down in the relevant BIS specifications. All materials and articles brought by the contractor to the site for use shall conform to the samples approved by the Engineer-in-Charge which shall be preserved till the completion of the work.
15. The contractor shall ensure quality construction in a planned and time bound manner. Any sub-standard material/work beyond set out tolerance limit shall be summarily rejected by the Engineer-in-Charge.

16. BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/materials. Wherever BIS marked materials are brought to the site of work, the contractor shall if required, by the Engineer-in-Charge furnish manufacturers test certificate or test certificate from approved testing laboratory to establish that the material produced by the contractor for incorporation in the work satisfies the provisions of BIS codes relevant to the material and/or the work done.
17. The contractor shall procure all the materials at least in advance so that there is sufficient time to testing and approving of the materials and clearance of the same before use in work.
18. All materials brought by the contractor for use in the work shall be got checked from the Engineer-in-Charge or his authorized representative of the work on receipt of the same at site before use.
19. The contractor shall be fully responsible for the safe custody of the materials issued to him even if the materials are in double lock and key system.

#### **9.4 Natural calamity**

No payment will be made to the contractor for any damage caused by rain, snow fall, floods, dampness, fire, sun or any other natural cause whatsoever during the execution of work. The damage to the work due to above reason, if any, shall have to be made good by the contractor at his own cost and no claim on this account shall be entertained.

#### **9.5 Stocking and Disposal of Materials & Debris**

1. The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, compound wall, services etc. are to be constructed.
2. After completion of work the agency shall remove materials and debris etc. from site and shall be disposed off at any suitable place as per the direction of Engineer-in-Charge, at no extra cost.
3. Contractor's job will also include removing of all malba and debris arising in the process of painting including washing of roads to remove unnecessary stains of paint, at no extra cost.
4. The contractor shall conduct work so as not to interfere with or hinder the progress or completion of the work being performed by other contractor(s) or by the Engineer-in-Charge and shall as far as possible arrange his work and shall place and dispose of the materials being used or removed so as not to interfere with the operations of other contractor or he shall arrange his work with that of the others in an acceptable and coordinated manner and shall perform it in proper sequence to the complete satisfaction of others.
5. For construction/renovation works which are likely to generate malba/rubbish to the tune of more than a tempo/truck load, contractor shall dispose of malba, rubbish & other unserviceable materials and wastes at their own cost to the notified/specified dumping ground and under no circumstances these shall be stacked/dumped, even temporarily outside the construction premises.

6. Dismantled but useful materials/components/equipment, if any, should be returned to the Institute as per the direction of Engineer-in-Charge.

## 9.6 Painting, if applicable

1. Contractor will thoroughly clean all paint marks left here and there due to spilling and splashes of paint at no extra cost.
2. Contractor will first submit the shade cards of relevant make of paint to IIT for approval of color before procuring the paint in bulk.
3. No mixing will be allowed with Stainer to achieve a particular color. Contractor will procure direct colour paint of approved shade and apply directly
4. Contractor shall have to brought at least 50% quantity of total **thermoplastic paint** and shall deposit it in the custody of concerned site Engineer before start of work. The consumption shall be monitored by the Institute. All empty drums shall have to be kept till completion of work.

## 9.7 Safety and Security

1. The contractor has to follow all safety norms as laid down in National Building Code of India. All the workers shall be equipped with the required safety gadgets while working at site such as ISI marked helmets, Shoes and safety belts, gumboots, gloves etc.
2. The contractor, the authorized representative(s), workmen etc., shall strictly observe orders pertaining to fire precautions prevailing in the area.
3. The contractor shall be fully responsible for the safe custody of materials brought by him/ issued to him even though the materials may be under double lock key system.
4. Contractor will arrange proper metal ladders, M.S. double scaffolding (for working, painting, etc. at higher levels) at his own cost and will take all safety measures like double harness safety belt, mechanized electrically operated platform etc. If it is observed that work is proceeding without adequate safety precautions, work may be stopped by Engineer-in-charge and in such cases, contractor will be solely responsible for delay and its consequences thereof.
5. The contractor shall be responsible for the watch and ward/guard of the buildings, safety of all fittings and fixtures including sanitary and water supply fittings and fixtures provided by him against pilferage and breakage during the period of installations and thereafter till the building is physically handed over to the department. No extra payment shall be made on this account.
6. The contractor shall take all precautions to avoid accidents by exhibiting necessary caution boards day and night speed limit boards red flags, red lights and providing barriers. He shall be responsible for all dangers and incidents caused to existing / new work due to negligence on his part. No hindrances shall be caused to traffic during the execution of the work.
7. It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.
8. The Institute shall not have any responsibility or liability in case of any accident injury to the personnel to the contractor at work site or to the general public at the work site due

to mishandling equipment by the personnel of the contractor or any other similar reason. The responsibilities and liabilities for such accidents and incidents shall be borne by the contractor.

### **9.8 Approach to Site**

1. The tenderer shall see the approaches to the site. In case any approach from main road is required at site or existing approach is to be improved and maintained for cartage of materials by the contractor, the same shall be provided, improved and maintained by the contractor at his own cost.
2. Contractor shall take all precautionary measures to avoid any damage to adjoining property. All necessary arrangement shall be made at his own cost.

### **9.9 Water and Flooding**

1. The contractor shall have to arrange water of desirable quality for the construction purpose for which he may have to install water purifier at site or might have to bring/ purchase water from outside as per decision of Engineer-in-charge. Nothing extra shall be paid on this account.
2. For works below ground level the contractor shall keep that area free from water. If dewatering or bailing out of water is required the contractor shall do it and nothing extra shall be paid except otherwise provided in the items of schedule of quantities.
3. In case of flooding of site on account of rain or any other cause and any consequent damage, whatsoever, no claim financially or otherwise shall be entertained notwithstanding any other provisions elsewhere in the contract agreement. Also, the Contractor shall make good, at his own cost, the damages caused, if any.
4. The water charges (for water connection as well as tanker water) shall be borne by the contractor. Also, if the contractor obtains water connection for the drinking purposes from the Institute or any other statutory body, the consequent sewerage charges shall be borne by the contractor.

### **9.10 Acts and Laws**

1. The Contractor shall keep himself fully informed of all acts and laws of the Central & State Governments, all orders, decrees of statutory bodies, tribunals having any jurisdiction or authority, which in any manner may affect those engaged or employed and anything related to carrying out the work. All the rules & regulations and bye-laws laid down by Collector / MC etc. and any other statutory bodies shall be adhered to, by the contractor, during the execution of work.
2. The Contractor shall also adhere to all traffic restrictions notified by the local authorities.
3. All statutory taxes, levies, charges (including water and sewerage charges, charges for temporary service connections and / or any other charges, as applicable) payable to such authorities for carrying out the work, shall be borne by the Contractor.
4. The Contractor shall arrange to give all notices as required by any statutory / regulatory authority and shall pay to such authority all the fees that is required to be paid for the execution of work. He shall protect and indemnify the Institute and its officials & employees against any claim and /or liability arising out of violations of any such laws,

ordinances, orders, decrees, by himself/herself or by his/her employees or his/her authorized representatives. Nothing extra shall be payable on these accounts.

5. The fee payable to statutory authorities for obtaining the various permanent service shall be borne by the Institute.

### **9.11 Labour and Laws**

1. The Contractor shall display all permissions, licenses, registration certificates, bar charts, other statements etc. under various labour laws and other regulations applicable to the works, at his site office.
2. Huts for labour are not permitted within the premises of the Institute. No extra cost shall be payable even if the contractor provides such accommodation at a place as is acceptable to the local body.

### **9.12 Nondisclosure Agreement**

1. The Agency shall take all precautions not to disclose, divulge and/or disseminate to any third party any confidential information, proprietary information on the Institute business or security arrangements (including but not limited to the Assignment instructions, Schedules and other subsequent Arrangements) and/or business of the Institute. The obligation is not limited to any Scope and the Agency shall be held responsible in case of breach of the confidentiality of Institute's information.
2. If the Agency receives enquiries from Press/Media/Radio/Television or other bodies/persons, the same shall be referred by the Agency to Institute immediately on receipt of such queries.

### **9.13 Indemnification:**

1. The agency shall be directly responsible to indemnify the Institute against all charges, dues, claims, etc. arising out of the disputes relating to the dues and employment of the personnel deployed and further for any claim/compensation against all damages and accidents caused due to negligence on the part of the agents, employees and other personnel of the agency.
2. That the contractor shall keep the IITK indemnified against all claims whatsoever in respect of the employees deployed by the contractor. In case any employee of the contractor so deployed enters in dispute of any nature whatsoever, it will be the primarily responsibility of the contractor to contest the same. In case IITK is made party and is supposed to contest the case, IITK will be reimbursed for the actual expenses incurred towards Counsel Fee and other expenses which shall be paid in advance by the Contractor to IITK on demand. Further, the contractor shall ensure that no financial or Any other liability comes on IITK in this respect of any nature whatsoever and shall keep IITK indemnified in this respect.

### **9.14 Force Majeure:**

If at any time, during the continuance of this contract, the performance in whole or in part by either party of any obligation under this contract is prevented or delayed by reasons of any war, hostility, acts of public enemy, civil commotion, sabotage, fires, floods, explosion, epidemics

quarantine restriction, strikes, lockouts or acts of god (hereinafter referred to as events) provided notice of happenings of any such event, is served by party seeking concession to the other as soon as practicable, but within 21 days from the date of occurrence and termination thereof. Provided the Party satisfies Institute adequately of the measures taken by it. Neither party shall, by reason of such event, be entitled to terminate this contract, nor shall either party have any claim for damages against the other in respect of such non-performance or delay in performance. Further, the services under the contract shall be resumed as soon as practicable after such event has come to an end or ceased to exist and the decision of Institute as to whether the services have to resume or not shall be final and conclusive, provided further, that if the performance in whole or in part of any obligation under this contract is prevented or delayed by reason of any such event for a period exceeding 60 days, Institute may at his option, terminate the contract.

### **9.15 Dispute resolution**

1. The institute reserves the right to amend rules whenever and wherever considered necessary and appropriate. The same shall be intimated to the agency in due course.
2. Any dispute arising out of and in relation to this agreement shall be referred to the arbitration by sole arbitrator to be appointed by Director of the Institute. The arbitration would be conducted and governed by and under the provisions of Arbitration Act, 1996 and its amendments. Any legal dispute will be subject to jurisdiction of Kanpur Courts only and no other court shall have the jurisdiction.
3. Any dispute arising out of and in relation to this agreement shall be referred to the arbitration by sole arbitrator to be appointed by Director of the Institute. The arbitration would be conducted and governed by and under the provisions of Arbitration Act, 1996. Any legal dispute will be subject to jurisdiction of Kanpur Courts only and no other court shall have the jurisdiction.

### **9.16 Arbitration**

1. Except as otherwise provided anywhere in this Agreement, if any dispute, difference, the question of disagreement or matter, whatsoever, arises between the parties, as to the meaning, operation or effect of the Agreement or out of or relating to the Agreement or breach thereof, the same shall be referred to a Sole Arbitrator, to be appointment by the Director of the Institute at the time of the dispute.
2. If the Arbitrator, to whom the matter is originally referred, dies or refuses to act or resigns for any reasons from the position of arbitration, it shall be lawful for the Director of the Institute to appoint another person to act as Arbitrator in the manner aforesaid. Such person shall be entitled to proceed with the reference from the stage at which it was left by its predecessor, provided both the parties consent to this effect, failing which, the arbitrator shall be entitled to proceed on the matter de- novo.
3. It is a term of the Agreement that the party invoking the arbitration shall specify all disputes to be referred to arbitration at the time of invocation of arbitration under the clause.
4. It is a term of the contract that the cost of arbitration shall be borne by the parties themselves.
5. The place of the arbitration shall be Kanpur Nagar, Uttar Pradesh, India.

6. Subject as aforesaid, the provisions of the Arbitration and Conciliation Act, 1996 and any statutory modifications, amendments or re-enactment thereof and rules made thereunder and for the time being in force, shall apply to the arbitration proceeding under this clause.
7. Except as otherwise provided anywhere in this Agreement, the Arbitration proceedings shall be conducted in English and the Agreement shall be constructed, interpreted and governed by the law of India, for the time being in force.

### **9.17 Jurisdiction of Courts**

The court(s) at Kanpur Nagar, Uttar Pradesh, shall have the exclusive jurisdiction to try any as all the disputes(s) between the parties arising out this Agreement.

### **9.18 Special Conditions for Road Works**

1. Before the start of the work, the contractor shall submit the program of execution of work and get it approved form the Engineer-in-Charge and strictly adhere to the same for the timely completion of the project work.
2. The contractor shall, at all times, carry out work on the running road in a manner creating minimum interference in the flow of traffic as per direction of Engineer-in-Charge.
3. The contractor shall carry out true and proper setting out of the work under the supervision of the Engineer-in-Charge or his authorized representatives and shall be responsible for the correctness of the positions, levels, dimensions and alignments of all parts of the Road. If at any time, during the progress of the work, any error appears or arises in the position, level, dimensions or alignment of any part of the work, the contractor on being asked to do so by the Engineer-in-Charge, shall rectify such error to the entire satisfaction of the Engineer-in-Charge. The supervision and/or checking by the Engineer-in-Charge or his authorized representative shall not relieve the contractor of his responsibility for the correctness of any setting out of any line or level. The contractor shall carefully protect and preserve all benchmarks, pegs and pillars provided for the setting out of works.
4. All arrangements for traffic diversion during construction, including maintenance of diversion roads, shall be considered as incidental to the work and contractor's responsibility and nothing shall be payable to him in this respect.
5. The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades including signs, markings, flags, lights and flagmen as necessary at either end of the excavation/embankment and at such intermediate points as directed by the Engineer-in-Charge for the proper identification of construction area. He shall be responsible for all damages and accidents caused due to negligence on his part.
6. The contractor or his authorized representative should always be available at the site of work to take instructions from departmental officers and ensure proper execution of work. No work should be done in the absence of such authorized representative.
7. Royalty at the prevalent rates and all other incidental expenditure shall have to be paid by the contractor on all the boulders, metal, shingle, earth, sand, bajri etc. collected by him for the execution of the work direct to the concerned Revenue Authority of the State or Central Government. His rates are deemed to include all such expenditure and nothing extra shall be paid.

8. No claim for idle establishment & labor, machinery & equipment, tools & plants, and the like, for any reason whatsoever, shall be admissible during the execution of work as well as after its completion.
9. The Contractor shall supply, free of charge, all the materials required for testing. The contractor shall bear all the testing charges as required for the CGBM pavement as per IRC:SP:125-2019 as directed by Engineer-in-Charge.
10. The contractor will have to make his own arrangement for obtaining electric connection(s) from the Institute/or install generators at the site of work for systematic & timely execution of work.
11. The contractor shall have to submit the details of Mix plant/ all materials to be used in Cement Grouted Bituminous Mix that the contractor intend to bring and get approval of Engineer-in-Charge before commencement of the work.
12. Nothing extra shall be paid for cartage of any material to the site of work.

#### **9.18.1 Conditions for Bitumen**

1. The contractor shall procure bitumen of required grade as specified conforming to IS:73-1992 with up-to-date amendments and other relevant codes form the manufacturers of repute like Indian Oil Corporation Ltd., Hindustan Petroleum Corporation Ltd. and Bharat Petroleum Corporation Ltd. as approved by Ministry of Petroleum, Govt. of India and holding license to use ISI certification mark for their products.
2. Mode of Procurement
  - (a) HOT STRAIGHT RUN BITUMEN of Grade VG-10 & VG-30 for tack coat shall be brought at site in sealed drums only bearing following markings (legible):
    - i. Name of Manufacturer.
    - ii. Gross Wt., Net Wt. And Tare weight.
    - iii. Month and Year of Manufacture.
    - iv. Use before (date).
    - v. Type and Grade.
    - vi. Batch Number.
    - vii. 'ISI' Certification and Standard Mark.
    - viii. Name of Contractor/Supplier.
    - ix. Serial No. & Total Nos. Of drums in each batch.
  - (b) When bitumen is issued in drums, the same shall be stacked in fenced enclosures, to be provided by the contractor at his own cost, as directed by the Engineer -in-Charge, on one side of the roadway. The contractor shall be responsible for the watch & ward and safety of bitumen. The contractor shall facilitate the inspection of bitumen stockyard by the Engineer-in-Charge or his representative at any time.
  - (c) Bitumen shall be kept in joint custody of the contractor and the representative of the Engineer -inCharge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from

the Engineer-in-Charge. No heating of bitumen in drums for any purpose whatsoever shall be allowed.

3. **Sampling and Testing:** The contractor shall have to obtain and furnish test certificates issued by manufacturer to the Engineer -in-Charge in respect of bitumen procured by him. The samples shall be collected at discretion of Engineer-in-Charge and got tested as per provisions of IS:73/ MORTH/CPWD specifications from the IIT Kanpur Lab.
4. The contractor shall supply, free of cost, the bitumen sample required for testing.
5. In case the test result indicate that the bitumen procured by the contractor does not conform to the relevant BIS codes/specifications, the same lot shall stand rejected and shall be removed from the site of work by the contractor at his own cost within a week's time of written order form Engineerin-Charge to do so.
6. The bitumen content in the bituminous mix shall be checked by conducting the bitumen extraction test conforming to IRC: SP.11 at regular intervals during the progress of work; the actual consumption of bitumen shall be worked out based on such test results. The theoretical consumption shall be worked out based on the job mix formula and the actual consumption (based on the extraction test as well as the MAS account) if found less than the theoretical one, the recovery shall be made from the contractor for less use of bitumen. The work found executed with a bituminous mix having bitumen content lesser than a permissible variation of (-) 0.3% shall be considered as sub-standard work and hence shall be liable for rejection. However, nothing extra shall be paid if actual consumption so worked out is higher than theoretical consumption. This is without prejudice to action under other relevant clauses of the agreement.
7. Bitumen brought at site/Hot Mix plant and bitumen remaining unused after completion of work shall not be removed from site without written permission of the Engineer-in-Charge.

### **9.19 Particular Specifications for Road Work**

1. The work, in general shall be executed as per the description of item, drawing, particular specification & special conditions attached, MoRTH specifications for road and bridge works (Fourth revision) 2001, CPWD specifications 2019 Vol-I & II for dismantling and demolition works & road works, relevant IRC codes and IS specifications with correction slips issued up to the date of receipt of tender.
2. The necessary tests shall be conducted in the laboratory of IIT Kanpur.

#### **3. BITUMINOUS WORK**

- (a) Tack Coat: The work shall be done strictly in accordance with clause 503 and sub clauses thereto of MoRTH specifications for road and bridge works (Fourth revision) 2001. The tack coat will be applied by the bitumen distributor assembly capable of applying even and uniform tack coat of specified quantity.
- (b) Cleaning and Preparation of the Surface: The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and any extraneous material, and be otherwise prepared in accordance with the requirements of clauses 501.8 and 902 of MORTH Specification (4th Revision) 2001 as appropriate. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure jet, or by other means as directed by the Engineer-in-Charge.

**4. Cement Grouted Bituminous concrete (CGBC) as per IRC: SP:125-2019.**

The work shall consist of constructing a single layer of specified compacted thickness of cement grouted bituminous concrete consisting of crushed stone aggregate mixed with bituminous binder to serve as wearing course laid immediately after mixing, on a previously prepared base in accordance with the requirements of specification as laid down in clause 508 and sub- clauses thereto of MORTH specifications for road and bridge works (Fourth revision) 2001.

**GUIDELINES FOR CEMENT GROUTED  
BITUMINOUS MIX SURFACING FOR URBAN  
ROADS**

IRC:SP:125-2019

# GUIDELINES FOR CEMENT GROUTED BITUMINOUS MIX SURFACING FOR URBAN ROADS



INDIAN ROADS CONGRESS  
2019



# **GUIDELINES FOR CEMENT GROUTED BITUMINOUS MIX SURFACING FOR URBAN ROADS**

*Published by:*

**INDIAN ROADS CONGRESS**

Kama Koti Marg,  
Sector-6, R.K. Puram,  
New Delhi-110 022

**DECEMBER, 2019**

Price : ₹ 500/-  
(Plus Packing & Postage)

IRC:SP:125-2019

First Published : December, 2019

*(All Rights Reserved. No part of this publication shall be reproduced, translated or transmitted in any form or by any means without the permission of the Indian Roads Congress)*

Printed at India Offset Press, Delhi - 110 064  
1100 Copies

## CONTENTS

<b>S. No.</b>	<b>Description</b>	<b>Page No.</b>
	Personnel of the Highways Specifications and Standards Committee	i-ii
	Abbreviations	iii
1	Introduction	2
2	Scope	4
3	Materials	5
	3.1 Coarse Aggregate	5
	3.2 Fine Aggregate	6
	3.3 Bitumen	6
	3.4 Grout	6
	3.5 Design of Cementitious Grout	6
4	Bituminous Mix Design for CGBM	7
	4.1 Aggregate Gradation	7
	4.2 Determination of Dry Aggregate Air Voids	8
	4.3 Selection of Optimum Binder Content by Draindown Test	8
	4.4 Determining Compaction Effort	8
	4.5 Sample Preparation and Testing	9
	4.6 Selection of Job Mix Gradation	9
5	Optimization of Grout for CGBM	9
6	Recommendations for CGBM	10
7	CGBM Production	12
	7.1 At Laboratory Scale	12
	7.2 During Pavement Construction	12
8	Resilient Modulus, Fatigue Life and Strength of CGBM	12
9	Pavement Design	13

Appendix	: Mix Design, Methodology and Test Results for CGBM	14
Annexure A	: Outline of ASTM C29 for Determination of Dry Aggregate Air Voids	28
Annexure B	: Outline of ASTM D 6390 for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures	30
Annexure C	: Outline of ASTM D 2041 for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures	32
Annexure D	: Outline of ASTM C939 for Measuring the Flow Value of Grout using Flow Cone	35
Annexure E	: Construction of CGBM Pavements	37
References		39

**PERSONNEL OF THE HIGHWAYS SPECIFICATIONS  
AND STANDARDS COMMITTEE  
(As on 20.07.2019)**

1	Pandey, I.K. (Convenor)	Director General (Road Development) & Special Secretary to Govt. of India, Ministry of Road Transport and Highways, New Delhi
2	Balakrishna, Y. (Co-Convenor)	Additional Director General, Ministry of Road Transport and Highways, New Delhi
3	Kumar, Sanjeev (Member Secretary)	Chief Engineer (R) S, R & T, Ministry of Road Transport and Highways, New Delhi

***Members***

4	Behera, Bijan Kumar	Engineer-in-Chief (Civil) (Retd.), Odisha
5	Bose, Dr. Sunil	Head (Retd.), FPC Division, Central Road Research Institute, New Delhi
6	Chandra, Dr. Satish	Director, Central Road Research Institute, New Delhi
7	Gupta, D.P.	DG(RD) & AS (Retd.), Ministry of Surface Transport, New Delhi
8	Jain, R.K.	Chief Engineer (Retd.), PWD Haryana
9	Kapila, K.K.	Chairman & Managing Director, ICT Pvt. Ltd., New Delhi
10	Kukrety, B.P.	Associate Director, CEG Ltd., New Delhi
11	Kumar, Dr. Mahesh	Engineer-in-Chief (Retd.), PWD (B&R) Haryana
12	Lal, Chaman	Engineer-in-Chief (Retd.), PWD Haryana
13	Meena, H.L.	Secretary (Retd.), PWD Rajasthan
14	Nashikkar, J.T.	Secretary (Retd.), PWD Maharashtra
15	Nirmal, S.K.	Secretary General, Indian Roads Congress, New Delhi
16	Parida, Prof. (Dr.) M.	Deputy Director, Indian Institute of Technology, Roorkee
17	Patel, S.I.	Secretary (Retd.), PWD (Roads and Buildings) Gujarat
18	Prasad, R. Jai	Engineer-in-Chief (Retd.), PWD & Bangalore Mahanagar Palike, Karnataka
19	Rawat, M.S.	Executive Director, AECOM India Pvt. Ltd.
20	Reddy, Dr. K.S. Krishna	Secretary, Public Works, Ports & Inland Water Transport Department, Karnataka
21	Reddy, I.G.	Engineer-in-Chief (NH, CRF & Buildings), PWD Hyderabad
22	Reddy, Prof. (Dr.) K.S.	Professor, Indian Institute of Technology, Kharagpur
23	Sharma, S.C.	DG(RD) & AS (Retd.), Ministry of Road Transport and Highways, New Delhi
24	Shrivastava, A.K.	Additional Director General (Retd.), Ministry of Road Transport and Highways, New Delhi
25	Singh, Nirmaljit	DG(RD) & SS (Retd.), Ministry of Road Transport and Highways, New Delhi
26	Sinha, A.V.	DG(RD) & SS (Retd.), Ministry of Road Transport and Highways, New Delhi

IRC:SP:125-2019

27	The Chief Engineer (Basar, Toli)	PWD Arunachal Pradesh
28	The Addl. DGBR (North-West) (Kumar, Anil)	Border Roads Organisation, New Delhi
29	The Director (Tech.) (Pradhan, B.C.)	National Rural Infrastructure Development Agency, New Delhi
30	The General Manager (Projects) (Retd.) (Kaul, Satish)	National Highways and Infrastructure Development Corporation, New Delhi
31	The JICA Expert (Kitayama, Michiya)	Japan International Cooperation Agency, New Delhi
32	The Member (Projects) (Pandey, R.K.)	National Highways Authority of India, New Delhi
33	The Professor (Chakroborty, Dr. Partha)	Indian Institute of Technology, Kanpur
34	The Secretary (Vasava, S.B.)	Roads and Buildings Department, Gujarat
35	The Secretary (Roads) (Joshi, C.P.)	PWD Maharashtra
36	The Secretary (Tech.) (Tickoo, Bimal) (Retd.)	Roads and Buildings Department, Jammu & Kashmir
37	The Special Director General (Retd.) (Bansal, M.C.)	CPWD, Nirman Bhawan, New Delhi
38	Venkatesha, M.C.	Consultant
39	Wasson, Ashok	Member (Tech.) (Retd.), National Highways Authority of India, New Delhi

### ***Corresponding Members***

1	Jaigopal, R.K.	MD, Struct Geotech Research Laboratories (P) Ltd., Bengaluru
2	Justo, Prof. (Dr.) C.E.G.	Professor (Retd.), Emeritus ( <i>Expired in June, 2019</i> )
3	Veeraragavan, Prof. (Dr.) A.	Professor, Indian Institute of Technology, Madras

### ***Ex-Officio Members***

1	President, Indian Roads Congress	(Basar, Toli), Chief Engineer, PWD Arunachal Pradesh
2	Director General (Road Development) & Special Secretary to Govt. of India	(Pandey, I.K.), Ministry of Road Transport and Highways, New Delhi
3	Secretary General, Indian Roads Congress	Nirmal, Sanjay Kumar

**ABBREVIATIONS**

All symbols are explained where they occur first. Some of the symbols are:

AAAT	-	Average Annual Air Temperature
AAPT	-	Average Annual Pavement Temperature
AMAT	-	Average Monthly Air Temperature
AMPT	-	Average Monthly Pavement Temperature
AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society of Testing and Materials
AUSTROADS	-	Association of Australian and New Zealand Road Transport and Traffic Authorities.
BC	-	Bituminous Concrete
BIS	-	Bureau of Indian Standards
CBR	-	California Bearing Ratio
CGBM	-	Cement Grouted Bituminous Mix
DAAV	-	Dry Aggregates Air Voids
DAVR	-	Dry Aggregate Void Ratio
DBM	-	Dense Bituminous Macadam
E	-	Resilient Modulus of Elasticity
GB	-	Granular Base
GSB	-	Granular Sub-base
IRC	-	Indian Roads Congress
ITS	-	Indirect Tensile Strength
MIST	-	Moisture Induced Sensitivity Test
$M_R$	-	Modulus of Rupture
MEPDG	-	Mechanistic Empirical Pavement Design Guide
MSA	-	Million Standard Axle
MoRT&H	-	Ministry of Road Transport & Highways
OGFC	-	Open Graded Friction Course
RMC	-	Ready Mix Concrete

SAMI	-	Stress Absorbing Membrane Interlayer
TSR	-	Tensile Strength Ratio
UCS	-	Unconfined Compressive Strength
$V_a$	-	Volume of Air Voids
$V_b$	-	Volume of Bitumen
VDF	-	Vehicle Damage Factor
VG	-	Viscosity Grade
VIM	-	Voids in Mix
VMA	-	Voids in Mineral Aggregate
WBM	-	Water Bound Macadam
WMM	-	Wet Mix Macadam
$\epsilon_t$	-	Horizontal Tensile Strain
$E_v$	-	Vertical Subgrade Strain
$\mu$	-	Poisson's Ratio
$\mu\epsilon$	-	Micro Strain

## **GUIDELINES FOR CEMENT GROUTED BITUMINOUS MIX SURFACING FOR URBAN ROADS**

The first development of the semi-flexible process was carried out in the 1950's in France, as a protection of asphalt concrete surface course against the attack of waste oils and fuels. Jean Lefebvre, a French construction company as a cost-effective maintenance alternative to concrete roads developed this technology. In India, the CGBM technology was initially developed by a premier laboratory and a few stretches were constructed with this technology. CGBM technology consists of having a high void bituminous mix in which highly flow able high strength grout is poured which occupies all voids and make it water tight. This also leads to substantial improvement in the engineering properties. Performance study on CGBM overlay was carried out by CRRI and noted that compared to conventional bituminous mixes there is substantial improvement in engineering properties of this material. This technology has been adopted by Surat Municipal Corporation and in several other city roads. National laboratory at Chennai was requested to develop the grout and conduct laboratory tests on CGBM samples to ensure that engineering properties recommended for grout and CGBM based on various references are achievable.

The task of preparation of these Guidelines was taken up by H-9 Committee during the tenure 2012-14. The initial guidelines prepared by Dr. Animesh Das, Professor, IIT Kanpur in the year 2012 and discussed in the then H-9 Committee. Based on various references and research work at IIT Kharagpur & CSIR-CRRI, New Delhi, the initial guidelines were modified by late Prof. B.B. Pandey, IIT Kharagpur. The H-9 Committee was reconstituted in the year 2015 and draft document was discussed during various meetings of H-9 Committee and finally approved in its meeting held on 19.11.2016 for placing before HSS Committee. The HSS Committee in its meeting held on 23.06.2017 decided to wait for performance report on CGBM trial sections laid by CSIR-CRRI and referred back the document to H-9 Committee in light of comments made by the HSS.

Thereafter, the H-9 Committee was reconstituted for the tenure 2018-20. The H-9 Committee in its meeting held on 14.04.2018 constituted a subgroup comprising Shri P.L. Bongirwar-Subgroup Leader, Shri Manoj Kumar Shukla, Dr. Ambika Behl, Shri Anil Jadhav, Shri Vikas Thakar, Dr. I.K. Pateriya, Dr. Rajan Choudhary, Dr. Siddhartha Rokade and Dr. G. Bharat to review the comments of HSS and consider outcome of CRRI Study on CGBM Trial in Surat and finalize the document. The modified draft was discussed during various meetings of H-9 Committee and approved in its meeting held on 29.09.2018 for placing before HSS Committee. The HSS Committee in its meeting held on 23.10.2018 decided to refer back these draft guidelines to H-9 Committee in the light of comments made by HSS members. The draft guidelines were again discussed in the H-9 Committee and were finally approved in its meeting held on 08.06.2019 for placing before the HSS Committee. The HSS Committee in its meeting held on 20.07.2019 decided that Convenor, H-9 Committee will modify the document based on written comments and verbal comments offered during the meeting and submit final document to IRC for placing before the forthcoming Mid-Term Council meeting. The Mid-Term Council in its meeting held on 9<sup>th</sup> and 10<sup>th</sup> August, 2019 at Goa approved the document for publishing.

The composition of H-9 Committee is given below:

Bose, Dr. Sunil	.....	Convenor
Singh, R.K.	.....	Co-Convenor
Jha, Bidur Kant	.....	Member-Secretary

***Members***

Behl, Dr. Ambika	Pateriya, Dr. I.K.
Bhargava, Rajeev	Rokade, Dr. Siddhartha
Bongirwar, P.L.	Sahoo, Prof. U.C.
Choudhary, Dr. Rajan	Sinha, A.V.
Das, Dr. Animesh	Srivastava, Ashish
Jadhav, Anil	Subramanian, R.
Kumar, Sanjeev	Swamy, Dr. A.K.
Kumar, Satander	Thakar, Vikas
Mathur, H.C.	HoD, FPD, CRRI (Shukla, Manoj Kumar)
Mathur, Sudhir	HoD, RPD, CRRI (Kumar, Dr. Rakesh)
Nirmal, S.K.	

***Corresponding Members***

Ganju, Col. (Retd.) V.K.,	Veeraragavan, Prof. A.
Lal, Chaman	

***Ex-Officio Members***

President, Indian Roads Congress	(Basar, Toli), Chief Engineer, PWD Arunachal Pradesh
Director General (Road Development) & Special Secretary to Govt. of India	(Pandey, I.K.), Ministry of Road Transport & Highways
Secretary General, Indian Roads Congress	Nirmal, Sanjay Kumar

**1 INTRODUCTION**

Flexible pavements are the most common types of pavement used for highways in India and rest of the world. Bituminous wearing course of such pavements often suffer wet weather damage which gets aggravated in cities due to flooding during monsoon. The pavements at traffic intersections, parking places and bus stops are noticeably damaged due to frequent braking action and fuel spillage. So, there arises a need for durable wearing course which is (i) strong enough to resist braking and accelerating effect of traffic (ii) fuel resistant (iii) impervious to water

and (iv) moisture resistant. Research at IIT Kharagpur and at CSIR-CRRI has shown that open graded bituminous layer grouted with a cementitious grout can form a durable wearing course. Some other research Institute had developed similar product which has been used at a few locations in Kharagpur, Surat and Amravati. Flexible and Rigid pavements are common in India and now composite pavements are emerging.

The present guidelines deal with the design, preparation and application procedure for CGBM to be laid over bituminous surface. Almost single graded bituminous mix (having voids more than 25% which is more than the voids in traditional dense graded bituminous mixes) is paved and grouted with cement grout as under:

i) Mixed with optimum dose of bituminous binder (sometimes fibers may be added to prevent drain down) (ii) paved over a base (iii) compacted to design density (iv) filled with cementitious grout slurry (sufficiently flowable cement grout is applied on the compacted surface). This cement grout is primarily prepared by mixing suitable proportions of cement, fine sand and water. Other materials like fly ash, micro silica, super plasticizers, fibres etc. may be adequately and suitably added in order to improve the grout flowability and strength of grout.

CGBM is to be generally used as surface layer, but it also has potential to be used as base course.

### **International Applications of CGBM**

The pavement surface made with this kind of technology seemed to have been developed in France during 1960s and was known as 'resin modified pavement'. In USA it was first applied during 1987 (1). Various countries where CGBM has been used include France, USA, Germany, Japan, Spain, Portugal, Sweden, Norway, Finland, Saudi Arabia, Great Britain, China, Denmark, Malaysia, South Africa and Austria etc. CGBM technology had been reportedly used in bus stations, parking areas, warehouses, roads, aprons, etc.

For Road Surface Treatments (RSTA), UK has developed a code of practice for grouted Macadam, approved by ADEPT (Association of Directors of Environment, Economy, Planning and Transport, UK) (2) and the same has also been approved by the Highway Authorities Product Approval Scheme (HAPAS), UK in 2006. CGBM was implemented by an organization called CIP Jointless Surfacing, England, primarily in Harbours, Airports, Warehouse Distributions, Bus-Depot Stations, Manufacturing-Production areas etc. However, in UK, there is no BSEN (British Standards, Europe) specification on CGBM as yet. In other parts of Europe like Denmark, Netherlands, Sweden etc. this technology has been extensively used. The Copenhagen Airport, Denmark already laid approximately 3 lac m<sup>2</sup> of CGBM. M/S BREMAT, Rosmalen, Netherlands carried out the execution and maintenance of this technology in Roundabouts, Intersections and Signals. Stockholm, Sweden implemented CGBM at different Bus stops and Bus-Depot stations, to bear the static loads and to diminish the chances of wearing and tearing.

In USA, primarily CGBM has been incorporated in Army bases, Air force Stations and Airports. McCord Air force Base, Washington and Logan International Airport, MA, has constructed CGBM pavement for having durable surface. To develop a fuel damage resistant surface Malmstrom Air Force base, Montana, has constructed wearing surface incorporating CGBM.

Mississippi Department of Transportation performed a project investigating grouted macadam at two signalized, heavily trafficked intersections.

In the Asia Pacific, CGBM has been widely implemented in Malaysia, China, Australia, Japan, Saudi Arabia etc. Kuala Lumpur City Council has implemented CGBM technology extensively in heavily trafficked surface, Bus Lanes in the city area and maintenance of this is taken care of by Kuala Lumpur City Hall, since 2001. In China, Ministry of Construction of Chinese Technologies had executed several projects in late 20<sup>th</sup> Century.

Considering the widespread application of CGBM around the world, it may prove to be an emerging sustainable technology in road infrastructure development. The advantages of using CGBM surface in comparison to conventional pavement are as follows:

- ✓ Resistance to oil induced damages caused due to fuel spillage
- ✓ Resistance to permanent deformation
- ✓ Resistance to abrasion/wearing
- ✓ Resistance against moisture induced damages
- ✓ Lower thermal susceptibility in comparison to flexible pavements
- ✓ Impermeability and good skid resistance property

These advantages enable CGBM surface to take care of some of the individual limitations linked to cement concrete and bituminous mixes. Past researchers have conducted laboratory studies on stiffness, tensile and compressive strength, Marshall Stability, thermal expansion coefficient, low temperature fracture, fatigue properties of CGBM and found to show satisfactory performance. Recently, CSIR-CRRI has conducted detailed laboratory testing and evaluation of Trial section of CGBM in two roads of Municipal Corporation in Surat, Gujarat. The laboratory study included testing for compressive strength, stability, indirect tensile strength, moisture sensitivity, oil induced damage, wheel tracking test, resilient modulus, modulus of rupture, dynamic creep, flow number, dynamic modulus, etc. The study conducted by CRRI on CGBM trial section included visual inspection for any surface distress, core analysis for verification of full depth grouting, volumetric analysis using micro-CT technique, surface friction measurement and FWD survey. Trial stretches were studied on rural roads in heavy rainfall areas of West Bengal, a bridge deck and Dadar flyover in Mumbai City, roads of Municipal Corporations of Mumbai and Surat, etc. have given good performance. In hot summer, the cement grouted wearing course did not display any bleeding or rutting.

## 2 SCOPE

These guidelines discuss construction of laying of surface layer for Cement Grouted Bituminous Mix (CGBM), preferably over an existing bituminous pavement. CGBM is based on the concept of preparing a coarse aggregate skeleton structure which is then filled with cementitious grout material. A few trial stretches are also in progress where it is proposed to change the conventional seal coat on bituminous premix carpet with cement grouted seal coat. Minor changes in gradation are made to create more voids. This new type of wearing course is suitable for traffic up to 30 msa, in case of a new flexible pavement or as an overlay/renewal coat over an existing flexible pavement; though it can be used for heavier traffic as well if the base is strong. Such pavements have the benefit of flexibility of the bituminous pavement while possessing advantage of rigid pavement as well. Typically, the open graded aggregates are coated with about 3.25% to 4.0% bitumen. However, CRRI study on CGBM with a specified gradation finds that lower limit of

binder content can be decreased up to 3% whilst using good aggregates of specific gravity more than 2.7. Once the paved high voids bituminous surface cools down to ambient temperature, the cementitious grout is poured over the surface which penetrates and fills up the voids and forms an impervious layer. It is ensured that grouting is achieved for full depth of high voids bituminous layer.

Properties of grout, method of construction of cement grouted bituminous layer as well as pavement design principles are included in the guidelines. Users of the guidelines should maintain a record of pavement performance periodically and send their feedback to Indian Roads Congress for the future revision of the guidelines.

### 3 MATERIALS

#### 3.1 Coarse Aggregate

The coarse aggregate shall consist of crushed rock retained on 2.36 mm sieve. It shall be clean, hard, durable of cubical shape and free from dust and soft organic and other deleterious substances. The aggregate shall satisfy the physical requirements given in **Table 1** and should satisfy the specifications of the surface dressing as per the MoRT&H Specifications. Since open graded aggregates coated with a binder is compacted by a road roller, Los Angeles Abrasion value shall be less than 30% to eliminate or the aggregate Impact value should be less than 24% to prevent crushing during rolling. The sum of flakiness and elongation indices must be less than 35%.

**Table 1 Physical Requirements of Coarse Aggregates for Cement Grouted Bituminous Mixes**

Property	Test	Method	Specification
Cleanliness	Grain Size Analysis	IS:2386 Part 1	< 2% passing 75 µm
Particle Shape	Combined Flakiness and Elongation Index	IS:2386 Part 1	<35%
Strength	Los Angeles Abrasion Value	IS:2386 Part 4	<30 %
	Aggregate Impact Value	IS:2386 Part 4	<24%
Polishing*	Polished Stone Value	IS:2386 Part 4	> 55%
Durability	Soundness (either Sodium or Magnesium) - 5 cycles		
	Sodium Sulphate	IS:2386 Part 5	< 12%
	Magnesium Sulphate	IS:2386 Part 5	< 18%
Water Absorption	Water Absorption	IS:2386 Part 3	<2%

- \*i) Polishing requirement does not apply when the coarse aggregate is used in the 19 mm CGBM.
- ii) If the minimum retained tensile test strength falls below 80%, use of anti – stripping agent shall be used as per requirement.

### **3.2 Fine Aggregate**

Fine aggregate (passing 2.36 mm sieve and retained on 75 µm sieve) shall consist of 100% crushed, manufactured sand resulting from stone crushing operations. The fine aggregate shall be clean, hard, durable, of fairly cubical shape and free from soft pieces, organic or other deleterious substances. The Sand Equivalent Test (IS:2720, Part 37) value for the fine aggregate shall not be less than 50. The Plasticity Index of the fraction passing the 0.425 mm sieve shall not exceed 4, when tested in accordance with IS:2720 (Part 5).

### **3.3 Bitumen**

The bitumen for CGBM shall be viscosity grade (typically VG-30/VG-40) complying with Indian Standard Specification for paving bitumen i.e. IS: 73 or Polymer Modified Bitumen (PMB) Grade 40 complying with the Indian Roads Congress Specification i.e. IRC:SP:53.

### **3.4 Grout**

Grout consists of the following constituents. The proper proportioning needs to be decided as per the observed results for Grout Flow and Grout Strength.

#### **3.4.1 Cement**

Ordinary Portland Cement OPC 43 or OPC 53 grade complying with IS 269-2015 shall be used.

#### **3.4.2 Sand**

The sand should pass 0.6 mm size so that the grout will enter into the air voids easily. Sand content may be minimized to achieve better quality of grout. Fine sand passing 45 µm can also give good results.

#### **3.4.3 Fly ash and Silica fumes**

Addition of fly ash and silica fumes will increase the grout flowability. The fly ash should conform to IS:3812 with minimum 65% passing 45 µm sieve.

#### **3.4.4 Super plasticizer/chemical stabilizers**

Super plasticizer (IS: 9103) and other chemical additives help in reducing the water requirement without reduction in strength of the grout, thus improving the flowability and helps in early gain of grout strength.

### **3.5 Design of Cementitious Grout**

The cementitious grout primarily consists of cement, sand and water and may contain other mineral additives such as fly ash, micro-silica, very fine sand and suitable chemical additives in suitable proportion so as to produce a material that can flow easily into the voids of the bituminous mix. At the same time, grout should have enough strength to withstand the traffic

load. Though aggregate bears most of the traffic load, the grout should be strong enough to resist the stresses caused by traffic without crushing. Proportion of sand and fly ash may be varied to optimize strength and flowability of grout. Fly ash and silica fume, also known as micro silica are used to improve strength, durability and the performance. Super plasticizer/chemical additive is used to get the required fluidity at the lower water contents for cement grout without loss of strength. Polymer additive in the powder form or liquid form imparts early strength to the mortar.

For design of cement grout, various proportion of cement, fine sand passing 600  $\mu\text{m}$  sieve, silica fumes, fly ash and ultra-water reducer are to be worked out to obtain desired properties. Extensive study at IIT Kharagpur indicated that the proportions of cement: sand: micro silica: fly ash of 40:40:10:10 and a super plasticizer of 0.5% by weight of the dry powder; all by weight and a water/binder ratio of 0.55 gave satisfactory results. Similarly, laboratory experiments done by other premier laboratory, with proportion of cement: sand: micro silica: fly ash of 38:10:10:42 with super-plasticizer of 0.3% and w/c of 0.25 have given satisfactory results to meet all desired properties as mentioned in **Appendix**. Possibly some other combinations may also be able to achieve the performance parameters as stated in **Appendix**. Since material properties may differ due to different sources, several mix design trials with different proportions are necessary. The grout should satisfy the following criteria:

- ✓ It should be sufficiently flow-able so that it can occupy the voids of the high voids bituminous mix.
- ✓ Sand present in the grout should not pose difficulty for easy flow of grout through the voids in the mix.

Any commercially available ready mixed dry powders (grout) can also be used if they meet the performance parameters, as stated in **Appendix**. The flowability of cement grout is to be measured using Flow Cone as per ASTM C939. The performance properties expected from grout and CGBM composite are given in **Table 3**.

## 4 BITUMINOUS MIX DESIGN FOR CGBM

### 4.1 Aggregate Gradation

The combined grading of the coarse and fine aggregates for CGBM is shown in **Table 2**. This Table consists of three gradations namely Gradation I, II & III for preparing bituminous mixes with voids suitable for CGBM, out of which Gradation I & II are as per Table 500-21 of MoRT&H Specifications for Surface Dressing and Gradation III is similar to Open Graded Friction Course as per ASTM. Gradation III has slightly lower air voids as compared to Gradation I and II. Generally, open gradations are preferred for CGBM so that minimum air void content of 25% is available in the bituminous mix skeleton. Selection of any gradation for CGBM can be made with the objective that cementitious grout flows freely into the voids of bituminous mix. Some general principles of selection of gradation for CGBM are discussed in **Appendix**.

**Table 2 Gradations of Aggregates for CGBM**

Gradation	Gr-I	Gr-II	Gr-III
Nominal Aggregate Size	19 mm	13 mm	13 mm
Nominal Layer Thickness	40-50 mm	30-40 mm	30-40 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing		
26.5	100	-	-
19.0	85-100	100	100
13.2	0-40	85-100	90-100
9.5	0-7	0-40	25-65
6.3	-	0-7	-
4.75	-	-	10-15
2.36	0-2	0-2	8-15
0.075	0-1.5	0-1.5	2-8

#### 4.2 Determination of Dry Aggregate Air Voids

The air voids in dry compacted (rodded condition) aggregates (having coarse and fine portion) is to be determined as per ASTM C29 (see **Annexure A** for outline of the test) or IS: 2386 Part 3. The formula used for the calculation of air voids in dry aggregates is given below in Equation 1.

$$\% \text{ Voids} = 100 [(S \times W) - M] / (S \times W) \quad \dots\dots\dots (1)$$

Where,

- $M$  = bulk density of the aggregate, kg/m<sup>3</sup>
- $S$  = bulk specific gravity (dry basis)
- $W$  = density of water, 998 kg/m<sup>3</sup>

#### 4.3 Selection of Optimum Binder Content by Draindown Test

Draindown of the loose bituminous mix shall be determined according to ASTM D 6390 (see **Annexure B** for outline of the test). The drainage test should be performed at the anticipated plant production temperature and should satisfy the specified maximum drain down of 0.30%. If the mixture fails to meet this requirement, then fibers can be added to a level that reduces drain down to the acceptable limit.

There is a scope for reduction in bitumen dose which improves resistance against water penetration and may increase the ratio of ITS wet/ITS dry, However, as this may make the mix more brittle, reduction of bitumen dose below 3.25% is not recommended. Adequate quantity of bitumen is needed to maintain the nature of the prepared CGBM as flexible layer.

#### 4.4 Determining Compaction Effort

The samples of high voids bituminous mix for CGBM can be prepared in different ways; namely (i) Marshall samples of 100 mm dia., (ii) Extracting cores from compacted slabs and (iii) extracting 100 mm dia. core from 150 mm dia. Marshall sample. Depending on the type of sample being prepared (in terms of mix composition and sample size), the compaction effort may vary from

case to case. Compaction effort needs to be worked out by analyzing the lowering rate of air voids in the sample being prepared with respect to increase in the number of blows (compaction effort). Out of three gradations given in **Table 2**, only 40 blows are suggested for Gradation I & II and 60 blows for Gradation III, all applied on one face of the Marshall sample only.

#### 4.5 Sample Preparation and Testing

Four samples for each of the trial gradations at the bitumen content selected as per draindown test are to be prepared. Three samples from each trial gradation shall be prepared with the optimum compaction effort as found out earlier and used to determine the volumetric properties of Marshall samples, and the fourth uncompacted loose mix sample shall be used to determine the theoretical maximum specific gravity ( $G_{mm}$ ) according to ASTM D 2041 (see **Annexure C** for outline of the test).

#### 4.6 Selection of Job Mix Gradation

Compact the specimens as discussed above and then remove them from the moulds once they cool down to ambient temperature (open graded mixes need to be handled carefully). Determine the bulk specific gravity ( $G_{mb}$ ) of the specimens (ASTM D3203). The uncompacted mix samples are used to determine the theoretical maximum specific gravity ( $G_{mm}$ ). Using  $G_{mb}$  and  $G_{mm}$ , the percent air voids ( $V_a$ ) and VMA are calculated by the formulas shown in Equations 2 & 3, respectively.

$$VMA = 100 - \frac{G_{mb} \times P_s}{G_{sb}} \quad \dots\dots(2)$$

$$V_a = \frac{G_{mm} - G_{mb}}{G_{mm}} \times 100 \quad \dots\dots(3)$$

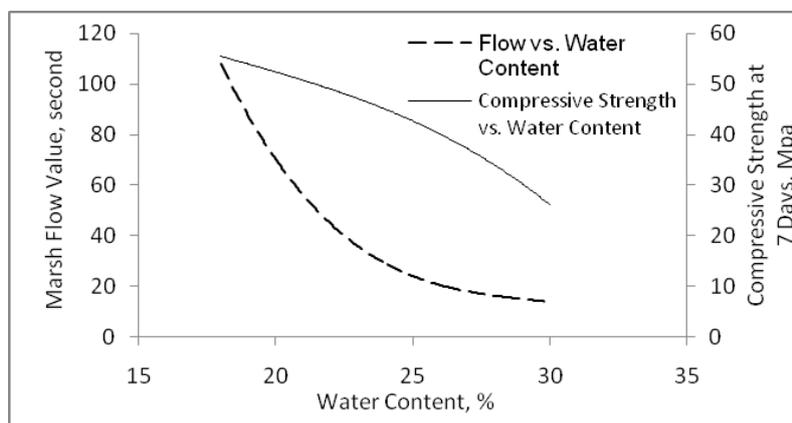
Where,

- $VMA$  = Voids in Mineral Aggregate
- $V_a$  = Percent Air Voids
- $G_{mb}$  = Bulk specific gravity of compacted mixture
- $G_{sb}$  = Bulk specific gravity of total aggregate
- $P_s$  = Percent of aggregate in mixture
- $G_{mm}$  = Theoretical maximum density of the mixture

### 5 OPTIMIZATION OF GROUT FOR CGBM

The grout slurry needs to have sufficient fluidity so that it can easily fill the air voids in the compacted mix. The fluidity of grout slurry is measured using Flow Cone as per ASTM C939 (See **Annexure D** for outline of the test). The strength of grout is basically evaluated in terms of its compressive strength measured on casted grout specimens (IS 4031 Part 6 or ASTM C109 or ASTM C579). The commercially available grout powder or own synthesised composition of grout as discussed in Para 4, needs to be optimised for quantity of mixing water such that the prepared

grout slurry has optimum balance between its flow value and strength parameter, as acceptable for the considered aggregate gradation. General trend of grout flowability and strength with respect to mixing water content is shown in **Fig. 1**. The quantity of mixing water content should be optimised towards its minimum value while maintaining full depth of grout penetration into the high voids bituminous mix and thus consequently to achieve higher grout strength.



**Fig. 1 Variation of Grout Flow and Strength Values with respect to Mixing Water Content**

## 6 RECOMMENDATIONS FOR CGBM

The designed CGBM composite material shall meet the following requirements, as given in **Table 3**.

**Table 3 Requirements of Cement Grouted Bituminous Mix**

Sr No.	Properties	Units	Test Method	Recommended Values for CGBM
1	<b>Aggregate Gradation</b>			
1.1	Aggregate grading	-	-	CGBM Gr-I, Gr-II, Gr-III or Any other grading giving 25-35% voids
1.2	Air Voids	%	ASTMD3203	25-35
1.3	Binder content	%	-	As per drain down test or min. 3.25%*
2	<b>Grout Material</b> (Formulated or Commercially available grout)			
2.1	Grade of Cement	-	IS 8112, IS 12269	OPC 43 or OPC 53
2.2	Fly ash specification	-	IS 3812 part 2 (min. 65 % passing 45 micron)	Fly ash for concrete application
2.3	<b>Properties of Grout</b>			
2.3.1	Initial Setting Time	Hrs	IS 4031 Part 5	4-5
2.3.2	Final Setting Time	Hrs	IS 4031 Part 5	6-10

Sr No.	Properties	Units	Test Method	Recommended Values for CGBM
2.4	Characteristic Compressive Strength @28 days	N/mm <sup>2</sup>	ASTM C109 (size 50*50*50 mm)	40-100
2.5	Flexural strength at 28 days	N/mm <sup>2</sup>	IS 4031 Part8 (sample size-160*40*40 mm)	5-7
2.6	Fluidity ASTM C 939	sec	ASTM C 939	20-50
3	<b>CGBM Composite</b>			
3.1	Voids in CGBM @ 7 days	%	ASTM D3203	2-3
3.2	Full depth grouting	%	Visual	97-100
3.3	Compressive strength at 28 days	N/mm <sup>2</sup>	ASTM C39 (100mm dia. & 200 mm ht.)	>5
3.4	Resilient Modulus @ 28 days, 35°C	N/mm <sup>2</sup>	ASTM D4123	> 10000**
3.5	Flexural strength @ 28 days	N/mm <sup>2</sup>	ASTM C78 (Beam size 180*60*60 mm)	min.2.0
3.6	Marshal Stability @ 28 days, 60°C	kN	ASTM D6927	min. 60 (PI check this value) (60 kN=6000kg)
3.7	Indirect tensile strength @28 days, 35°C	N/mm <sup>2</sup>	ASTM D6931	min.1.0
3.8	Retained ITS strength at 28 days	%	AASHTO T283	97
3.9	CGBM layer thickness	mm	-	30 mm for traffic up to 5 MSA 40-50 mm for traffic > 5 MSA 30 mm for renewal coat if designed traffic is less than 30 MSA till next renewal cycle
3.10	Opening to traffic	-	-	After 24 hrs for light traffic Requirement can be specified by user
3.11	Skid resistance	BPN	ASTM E303	>50 in Wet & >60 in Dry Condition

\* Corresponds to specific gravity of aggregates being 2.7. In case, aggregates having high specific gravity of more than 2.7 are used, the minimum bitumen content can be reduced

\*\* For design purpose, Resilient Modulus value can be taken as 5000.

## 7 CGBM PRODUCTION

### 7.1 At Laboratory Scale

Brief description for method of preparation of CGBM composite along with the recommended values for different parameters and test results are described in **Appendix**. The recommended and acceptable values would depend on method of preparation of sample. **Appendix** also describes the method for sample preparation which is suggested as per the equipment available at project site laboratory. The various engineering properties of grout and composite CGBM recommended in **Table 3** are based on the methods of sample preparation and test procedure as described in **Appendix**.

### 7.2 During Pavement Construction

For field application of CGBM surface layer, different stages of work need to be accomplished. The existing bituminous surface is first cleaned and then emulsion (RS1) or low viscosity paving bitumen of VG 10 grade is spread over it as tack coat as per MoRT&H Specifications. A layer of open graded high void bituminous mix is then laid using the paver. Depending upon the grade of bitumen used, the mixed material shall be in the range of 140-170°C. The laying temperature shall be in the range of 130-150°C. The bituminous mix is then compacted with smooth wheeled roller, once its temperature is in the range of 80-100°C. The paved bituminous mix is then compacted with 10 tons static steel wheel roller for 4 to 6 passes to obtain the desired density and the target air voids. Once the compacted bituminous surface cools down to ambient temperature, the requisite quantity of cementitious grout material mixed thoroughly with water can then be poured and spread uniformly over the entire porous surface. Cement grout preferably can be prepared in Pan Mixer so that all ingredients gets fully inter mixed. If patented intimately mixed dry powder is available, then use of Pan Mixer can be avoided and any simple blending equipment to produce liquid grout can be used. Grout can also be produced in the mixer of RMC plant. Grout would automatically flow into voids under the effect of gravity and its flowability. Sweeping or simple such techniques can be adopted to accelerate the process of grout penetration. Any excess grout observed on the surface shall be removed and any unfilled air voids observed are to be again filled with grout. The grout spread over the high voids bituminous mix surface is allowed to set for one day and then the section is cured by sprinkling of water for 7 days. The grouting operation should not be done in rainy or snowy environment. The field procedure to be adopted and the corresponding stages for laying the CGBM surface are outlined in **Annexure E**.

## 8 RESILIENT MODULUS, FATIGUE LIFE AND STRENGTH OF CGBM

In a typical case the Resilient Modulus (E) measured from Indirect Tensile test (ASTM D4123) for the cement grouted bituminous mix were found to vary from 12000 MPa to 15000 MPa in the laboratory at temperature 35°C. However, a reduced modulus of 5000 MPa may be considered for pavement design considering (i) variability in grading of aggregates (ii) partial penetration of grout in the field and (iii) cracks caused by the construction traffic. The modulus of rupture ( $M_R$ , for Flexural strength) was found to be 2.5 MPa. A value of 1.25 MPa may be considered as the  $M_R$  value of the grouted macadam for the purpose of checking adequacy of pavement crust. Poissons ratio ( $\mu$ ) may be taken as 0.25. The resilient modulus and the modulus of rupture values

can be used to check design adequacy to ensure that the Cement Grouted Bituminous Mix does not crack prematurely.

The fatigue life calculation of CGBM suggested by IIT Kharagpur is given below in Equation 4.

$$N = 10^{17.6019} \times (1/e)^{4.6099} \times (1/E)^{0.6171} \quad (R^2 = 0.77) \quad \dots\dots(4)$$

CSIR-CRRI based on their laboratory evaluations of CGBM samples prepared in the laboratory and cores taken from trial sections have found that Resilient Modulus (E) and Indirect Tensile Strength (ITS) of CGBM varies with temperature and loading. Therefore, CGBM can be concluded as Visco-elastic material.

## 9 PAVEMENT DESIGN

Elastic layered analysis applied for the analysis of flexible pavements can be used for the design of composite pavement as well. Parameters to be considered for design are CBR of the soil, elastic modulus of the granular layers, elastic modulus of the grouted bituminous layers, Poisson's ratio of different layers and design traffic in terms of standard axles.

At present, the structural design (layer thickness) of pavements having CGBM layer can be worked out using the Fatigue Equation as given by IIT Kharagpur and mentioned above in Para 8. Modulus of different types of bases, sub bases and sub grades can be taken from IRC:37-2018.

Based on studies done at Nottingham University, CSIR-CRRI, New Delhi and IIT Kharagpur, the resilient modulus of CGBM can be taken as 5000 MPa (based on laboratory evaluated values ranging from 8000 to 15000 MPa at test temperature of 35°C).

## MIX DESIGN, METHODOLOGY AND TEST RESULTS FOR CGBM

Mix design for high void bituminous mix is based on the requirement to achieve high volume of interconnecting voids. The morphology of the voids produced should be such that it allows easy flow of the grout through them and then their subsequent filling with the flowing grout itself. The design objective of high voids bituminous mix differs from that of conventional dense graded bituminous mixes. The main design criterion for high void bituminous mixes being: (a) optimum binder content while limiting the drain down and (b) compaction effort needed to achieve optimal density and requisite volume of interconnected air voids. The results shown in this **Appendix** for Gradings I, II & III of CGBM have been obtained from test conducted at CSIR-CRRI, IIT Kharagpur and another premier laboratory. Detailed methodology, test procedure, sample preparation, test results of laboratory prepared samples and field core samples are given in this **Appendix**. The compiled test results for the three considered gradations of CGBM are given in **Table A1 to A3**.

### 1. Aggregate Gradation and its Effect on Packing Characteristics

Air voids content in compacted bituminous mix will depend to a greater extent on the gradation of aggregate, binder content, type of binder and compaction method and energy used to compact the same. The packaging characteristics of different gradations can be defined by imparting similar compaction efforts and determining the voids. Different methods for determining air voids in an aggregate gradation are discussed below. These can be used to check the relative suitability of different gradations for preparation of high voids bituminous mixes.

#### a. Using IS 2386 Part 3

The aggregates selected for the specific gradation should be mixed thoroughly and then, filled into a cylindrical vessel of 250 mm diameter and 15 liters capacity, in three layers. Each layer should be subjected to 25 strokes of round edged tamping rod of 16 mm diameter. Dry Aggregate Air Voids (DAAV) can then be determined by the following equation:

$$\text{Air voids in Dry Aggregate} = \frac{G_s - \gamma}{G_s} \times 100$$

where

Air voids in Dry Aggregate is in percentage

$G_s$  = specific gravity of the aggregate,

$\gamma$  = bulk density in kg/litre

#### b. Using ASTM C29

The air voids in dry compacted (rodded condition) aggregates (having coarse and fine portion) can also be determined as per ASTM C29 (see **Annexure A**

for outline of the test). The formula used for the calculation of air voids in dry aggregates is given below:

$$\% \text{ Voids} = 100[(S \times W) - M]/(S \times W)$$

Where,

- M = bulk density of the aggregate, kg/m<sup>3</sup>  
 S = bulk specific gravity (dry basis)  
 W = density of water, 998 kg/m<sup>3</sup>

## 2. Selection of Aggregate Gradation for Grouted Mix

Preparation of acceptable CGBM mix in laboratory depends on two criterions: i) Preparation of high voids bituminous mix, and ii) Proper grouting of the prepared mix. It is also observed that the amount of grout penetration in mix is related to the air void content and vertical permeability of the compacted high voids bituminous mix. The two parameters i.e. vertical permeability (mm/s) and vertical flow rate can be measured as per BS EN 12697 which can indicate the relative performance of different grout mix. There is a good relation between voids in mix and permeability as expected, i.e. higher the VIM, higher will be the vertical permeability. It is also observed that the amount of grout penetrating in mix is related with the air void content and vertical permeability of mix. Voids in Mineral Aggregate (VMA) is an important mix parameter which relates to the volume of binder and air void content that can be incorporated in compacted mix. The threshold values in terms of different dry aggregate and mix parameters required for satisfactory grout penetration have been identified for the three considered CGBM gradations and are listed below in **Table A1**.

**Table A1 Threshold Values for Aggregate and Mix Parameters**

Parameters	Specified Value	
	Gr-I & Gr-II	Gr-III
DAAV(Dry aggregate air Voids) %	44	38
DAVR (Dry aggregate void ratio)	0.6	0.6
VIM (Voids in mix) %	35	30
VMA (Voids in Mineral aggregate) %	40	35

These values can be helpful in selection of appropriate aggregate gradation for design of high voids bituminous mixes. The series of experiments conducted at IIT Kharagpur has led to following conclusions:

- I. Dry Aggregate Air Voids (DAAV) and Dry Aggregate Void Ratio (DAVR) which represent packaging characteristics of dry aggregate are related to each other.
- II. Vertical permeability and air voids are related.
- III. The aggregate packing parameters DAAV and DAVR have good correlation with air voids in the compacted mix, vertical permeability and voids in mineral aggregate.
- IV. The amount of grout penetrating the mix as correlated strongly with air voids content and also with vertical permeability.

- V. Threshold values are evolved for different paving characteristics and mix volumetric parameters for designing bituminous mix for satisfactory grout penetration.
- VI. Use of finer sand fraction can improve the flow value and increase the degree of grout penetration. Full depth grout penetration is observed with sand with maximum size of 0.6 mm.

### 3. Determination of Optimal Bitumen Content

The determination of optimal bitumen content for all three gradations is based on the binder draindown test as per ASTM D6390. For all gradations, bituminous mixtures were prepared at different binder contents in increment of 0.5%. Drain down loss criteria of 0.3% (maximum) for high void bituminous mix is considered for selecting the optimum binder content.

### 4. Compaction Effort

There are no proper criteria for selection of number of blows/gyrations for the compaction of high voids bituminous mixes. For determining the optimum compaction effort, the bituminous mixes were compacted using Marshal Compactor with incremental variation of compaction effort. Cylindrical specimens of 100 mm diameter were prepared using a 100 mm diameter split mould for all considered aggregate gradations. For each aggregate gradation, cylindrical samples were compacted at various blows (20 to 70) of Marshall Hammer with increment of 10 blows applied on one face of the specimen. Then the volumetric study for each specimen of compacted samples was carried out, which is based on bulk specific gravity of compacted mix ( $G_{mb}$ ), theoretical maximum specific gravity of mix ( $G_{mm}$ ) and bulk specific gravity of aggregates ( $G_{sb}$ ). Three samples were prepared for each specimen. The formula used for calculation of Air Voids ( $V_a$ ) in the compacted bituminous mix and Voids in Mineral Aggregates (VMA) are given below.

$$V_a = \frac{G_{mm} - G_{mb}}{G_{mm}} \times 100$$

Where,

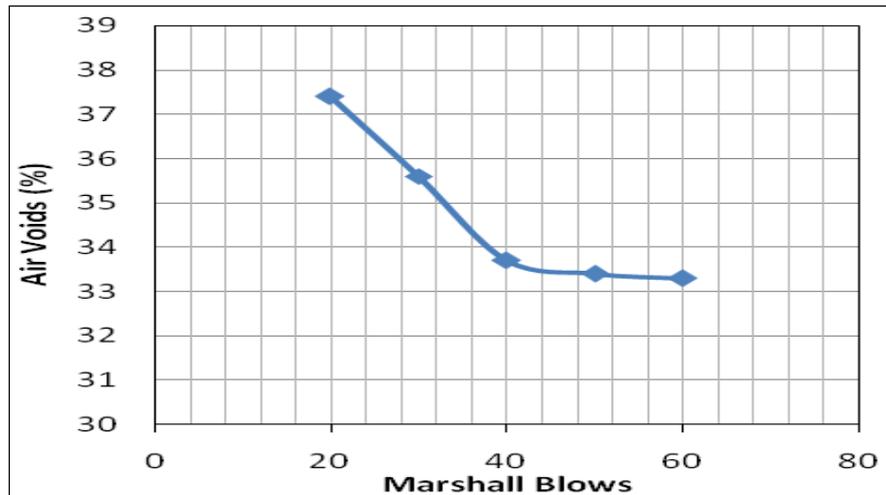
- $V_a$  = air voids in compacted mix (percentage)
- $G_{mm}$  = theoretical maximum specific gravity of mix
- $G_{mb}$  = bulk specific gravity of compacted sample

$$VMA = 100 - \frac{G_{mb} \times P_s}{G_{sb}}$$

Where,

- VMA = voids in mineral aggregate (%)
- $G_{mb}$  = bulk specific gravity of compacted sample
- $P_s$  = percentage of aggregate by total weight of mix
- $G_{sb}$  = bulk specific gravity of the aggregate

Theoretical maximum specific gravity of loose bituminous mix was measured as per ASTM D2041. Since the specimens have high air void content, their bulk density was determined as per ASTM D3203 which mentions the estimation of the specimen bulk volume from dimensions. One of the typical graphs obtained while optimizing the compaction effort i.e. number of Marshall Hammer blows for bituminous mix of Gr. II is shown in **Fig. A1**. The optimum number of Marshall Hammer blows required for Gr.-I & Gr.-II are 40 and for Gr.-III it is 60, all Marshall Hammer blows applied on one face only.

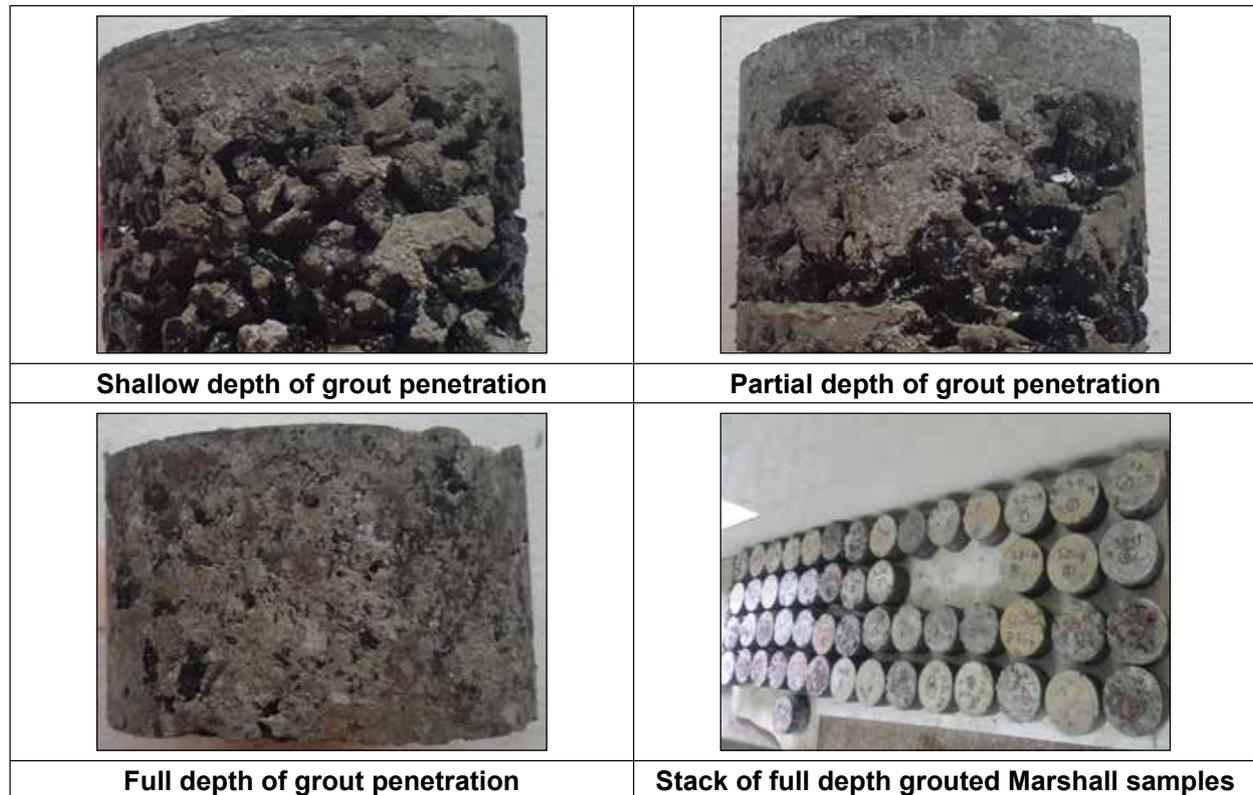


**Fig. A1** Compaction Effort vs. Air Voids

## 5. Optimization of Grout Slurry

The cementitious grout consists of cement, water and super plasticizer in suitable proportion so as to produce a material that can flow easily into the voids of the bituminous mix. Additional mineral additives, like fly ash, slag, micro silica etc. can also be used to develop suitable grout material. It is generally noted that maximum size of sand should not be more than 0.6 mm for improved penetration.

It is very clear that flow of grout material increases with increase in water content with simultaneous decrease in its compressive strength. The flow characteristic of the grout should be evaluated using a Flow Cone as per ASTM C939 guidelines. Minimum three trials for measuring the grout flowability should be performed and average value should be reported. Inappropriate flow value or lower flowability of prepared grout slurry can result in failure of full depth grout penetration. When talking particularly about Gr.-II, different extent of grout penetration achieved with gradual increase in mixing water content is shown in **Photo A1**. The setting time of the grout should be determined as per IS 4031 Part 5 guidelines. It is preferable to have initial setting time of 4-5 hours and final setting time of 6-8 hours. Minimum two trials should be carried out in arriving at the initial and final setting time. The variation of grout compressive strength with respect to mixing water content should also be studied. The compressive strength of the grout should be determined as per IS 4031 Part-6 or ASTM C109 or ASTM C579. The average value of compressive strength of 3 cubes of 50x50x50 mm size should be reported. The flexural strength of the cementitious grout can be determined as per IS 4031 Part 8 using beams of size 160x40x40 mm size.



**Photo A1 Extent of Grout Penetration into the samples of High Voids Bituminous Mixes**

## 6. Preparation of CGBM Samples

The evaluation of the CGBM for different parameters was performed on laboratory prepared samples of different sizes and shapes. As such, varying shape and sizes required for CGBM samples were 100 mm diameter & 63 mm height cylindrical samples for ITS, stability, resilient modulus, Moisture Induced Sensitivity Test (MIST); 100 mm diameter & 180 mm height cylindrical samples for compressive strength test; 100 mm diameter & 150 mm height cylindrical samples for dynamic modulus and flow number tests; rectangular slab for rutting test; rectangular beams for flexural strength or modulus of rupture test. Various types of grouted bituminous mix samples are shown in **Photo A2**. For preparation of these samples, the following steps can be followed:

- a) Fill the moulds (Marshall or Gyratory or Slab) with freshly prepared hot high voids bituminous mix prepared as per design mix requirements and spread it uniformly.
- b) Compact the mix using proper compaction method as per the type of sample being prepared (Marshall or Gyratory or Slab) up to the optimal density of mix, as discussed in Para 4. Preferably the weight of the hammer should be 4.5 Kg and above. Complete the compaction within 3 minutes, before the mix temperature drops below the specified requirements.
- c) Once the temperature of the compacted mix drops down to ambient temperature (near about 50-60°C), the cementitious grout can then be poured slowly on the surface and if needed, the grout can be spread uniformly using a small scrapper/

brush. The corners and edges of the moulds may be sealed from outside to prevent any possible leakage of grout from it.

- d) The grouted mix can then be de-moulded after 24 hours and should be cured with moistened jute bags for at least 3 days. Direct water curing is not recommended.
- e) Marshall Core samples of size 100 mm dia. and rectangular beam samples can be extracted from slabs using core drilling machine and saw cutter respectively.



**Photo A2 Different Types of CGBM Samples prepared in Laboratory**

## 7. Laboratory Based Evaluation of CGBM Samples

All laboratory prepared samples of CGBM were first checked for their basic physical parameters like dimensions, bulk density, bulk specific gravity, etc. The extracted samples are then ready to be used for different tests.

### a) Mechanical Strength Parameters of CGBM

Various laboratory tests were performed in order to determine different strength parameters of CGBM samples are described below with their test results mentioned in **Table A3**.

#### I. Indirect Tensile Strength (ITS)

The Indirect Tensile Strength (ITS) test should be performed as per ASTM D 6931 on Marshall Samples of 100 mm diameter. ITS test method consists of applying a load along the diametrical axis of the cylindrical sample at constant deformation rate of 51 mm/minute and determining the maximum vertical load taken by the sample at time of failure. Failure point is defined as the point after which there is no further increase in load. Before testing, the specimens should be temperature conditioned for different test temperatures like 25, 35 or 45°C. The maximum load  $P$ , taken by the sample is then used to calculate the Indirect Tensile Strength as per the equation given below.

$$ITS = \frac{2P}{\pi Dt}$$

Where,

- $ITS$  = Indirect Tensile Strength (MPa)  
 $P$  = load at failure (N)  
 $t$  = height/thickness of specimen (mm)  
 $D$  = diameter of specimen (mm)

## II. Stability and Compressive Strength

Marshall Stability test determines the shear strength of the material. Marshall stability and compressive strength for CGBM were tested as per ASTM D6927 and ASTM C39 respectively. The formula used for the calculation of compressive strength is given below.

$$f_{cm} = \frac{4000 P_{max}}{\pi D^2}$$

Where,

- $f_{cm}$  = compressive strength, MPa  
 $P_{max}$  = maximum load, kN  
 $D$  = average measured diameter, mm

## III. Modulus of Rupture

The developed composite material (CGBM) was tested for its flexural strength as per ASTM C78. The beam sample being tested for its flexural strength under third-point loading condition is shown in **Photo A3**. The equation used for the calculation of flexural strength is given below.

$$R = \frac{PL}{bd^2}$$

Where,

- $R$  modulus of rupture, MPa  
 $P$  maximum applied load, N  
 $L$  span length, mm  
 $b$  average width of specimen, mm  
 $d$  average depth of specimen, mm



**Photo A3 Flexural Strength Test under Third Point Loading Condition**

#### IV. Resilient Modulus

Resilient modulus is used as an input parameter for pavement design and evaluation. This test should be performed using the repeated indirect tensile test method as per ASTM D4123. The test setup for the testing of resilient modulus of elasticity value under indirect tensile loading condition is shown in **Photo A4**. CGBM samples cured for period of 7/28 days were used for determination of the resilient modulus. The equation used for the calculation of resilient modulus is given below.

$$E_R = \frac{P(v_R + 0.27)}{t\Delta H}$$

Where,

- $E_R$  = resilient modulus of elasticity, MPa
- $v_R$  = resilient Poisson's ratio
- $P$  = repeated load, N
- $t$  = thickness of specimen, mm
- $\Delta H$  = recoverable horizontal deformation, mm



**Photo A4 Resilient Modulus Test Setup**

#### b) Performance Evaluation

In order to have an assessment of the expected field performance of the CGBM, different performance related laboratory tests were performed on the CGBM samples. The actual field performance can only be checked by regular monitoring and evaluation of the laid sections. The laboratory-based performance studies done on CGBM are given as follows:

##### I. Rutting

Rutting performance of the CGBM mixes were studied at 60°C temperature using wheel tracking device. The rectangular slab of requisite size can be saw-cut out of a larger slab. Grouted CGBM slab being tested for 'rutting'

using Wheel Tracking Device is shown in **Photo A5**. The test slabs are subjected to vertical pressure of 620 kPa applied through 50 mm wide wheels having diameter of 200 mm and running at speed of 60 passes per minute. Each sample is subjected to 20,000 passes (10,000 to and fro repetitions) of the wheel load. The rutting test results for CGBM is negligible (< 2 mm after 20000 passes) indicating good performance of CGBM against rutting.



**Photo A5 Wheel Tracking Test on CGBM sample**

## II. Moisture Resistance Measurement using MIST

Moisture induced damage is related to the loss in strength due to reduced adhesion between aggregate and bitumen along with reduction in cohesive property of binder material. Moisture Induced Sensitivity Test (MIST), as per ASTM D7870 can be followed in which an accelerated moisture conditioning method with cyclic loading is used. The MIST equipment and Marshall Samples being kept inside the MIST chamber are shown in **Photo A6**. After completion of moisture conditioning cycles on the CGBM samples, the Tensile Strength Ratio (TSR) can be evaluated to quantify the performance of CGBM mixes.



**Photo A6 MIST Equipment with Test Sample being placed inside the Chamber**

Alternate methods of sample preparation and testing as done by leading laboratories are presented in following section. The stages of sample preparation and corresponding photos are shown in **Photo A7**.

## **SAMPLE PREPARATION AND TEST PROCEDURE**

### **1.1. Open Graded Friction Course (OGFC)**

The Open Graded Friction Course, OGFC should be designed for air voids in the range of 25-30%. The mix gradation given in **Table 2** can be used to obtain the specified air voids. VG-30 or above grade of bitumen should be used for the OGFC mixes. Bitumen content of 3.0-3.5% is adequate for uniform coating of aggregates and compaction of the mix. MoRTH Section 500 should be used for preparation of bituminous mix.

Care should be taken in selection of the bitumen content, as excess bitumen may lead to bleeding and drain down condition. It is preferred to make first the OGFC slabs which represent similar to field condition. OGFC slab specimen of size 700×150×63 mm (See **Photo A7**) can be prepared as described below:

- a) Fill the moulds with bituminous mix having the temperature around 130°C and spread uniformly.
- b) Compact the mix with vibration compaction hammer. Preferably the weight of the hammer should be 4.5 Kg and above. Complete the compaction within 3 minutes, before the mix temperature drops to 110°C.
- c) Extract Marshall Specimen of size 100×63 mm by using core drilling machine. Minimum three cores per slab shall be extracted.
- d) The voids in the Marshall specimen can be calculated as per ASTM D 3203 guidelines.

### **1.2. Cementitious Grout**

The cementitious grout consists of cement, water and super plasticizer in suitable proportion so as to produce a material that can flow easily into the voids of the bituminous mix. Additional mineral additives, like fly-ash, slag, micro-silica etc., are also useful in developing the suitable grout. Care should be taken to improve the flowability of grout by suitable additives and time required to discharge from the transit mixer within its workable period.

The flow characteristic of the grout should be evaluated using a Marsh cone as per ASTM C939 guidelines. The Marsh cone should conform to the specification. Initially the Marsh cone should be calibrated using water as per the ASTM guidelines. The flow tests with water should be 8.0±1.0 second conforming to the ASTM requirements. Minimum three trials with water and grout should be performed and average value should be recorded.

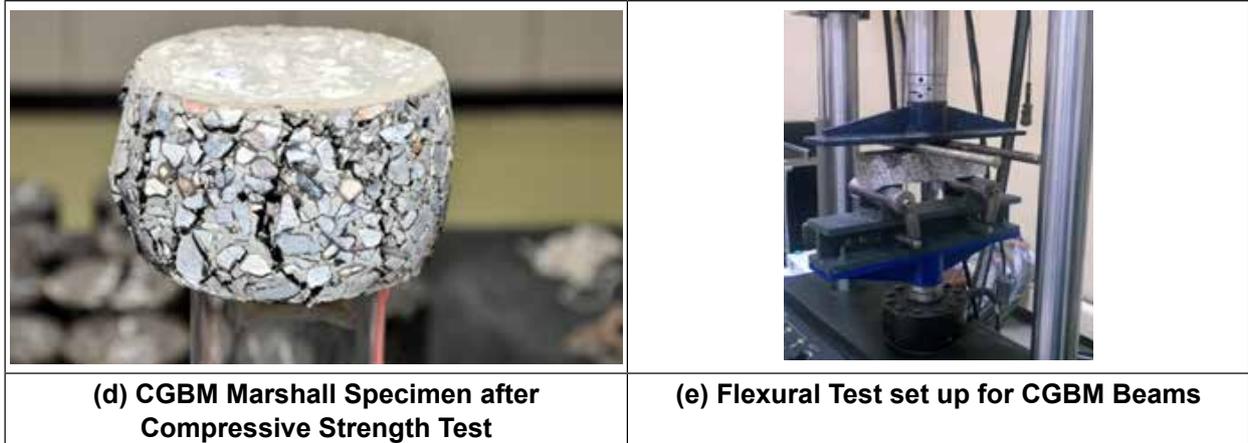
The setting time of the grout should be determined as per IS 4031, Part 5 guidelines. It is preferable to have initial setting time of 4-5 hours and final setting time of 6-8 hours. Minimum two trials to be performed in arriving at the initial and final setting time.

The compressive strength of the grout should be determined as per ASTM C 109 by casting three cubes of size using 50×50×50 mm. The average value of compressive strength of 3 cubes shall be recorded. The flexural strength of the cementitious grout can be determined as per IS 4031 Part 8 on 160×40×40 mm beam specimens. The average flexural strength of minimum 3 beam specimen shall be recorded.

**1.3. Cement Grouted Bituminous Macadam (CGBM)**

Based on the voids, calculate the quantity of grout required for filling of the OGFC slab. The slabs of OGFC mix should be filled with grout when the temperature comes down to ambient temperature or bituminous mix temperature falls to 50-60°C. The corners and all edges of the beam molds should be sealed from outside to prevent the leakage of grout. The cementitious grout can then be poured slowly on the OGFC slab and spread uniformly using a small scrapper. After a few minutes, a vibration compaction hammer should be used on the sides of the steel mold for 30 seconds to provide mild vibration and to ensure complete percolation of the grout to the bottom of the slab. Grouting should be continued until the entire calculated grout quantity is consumed by the OGFC slab. The slab can be de-molded after 24 hours and shall be cured with wet jute bags for 3 days. Direct water curing is not recommended. From slabs, standard Marshall Core samples and 189×63×63 mm beam samples shall be extracted. The Marshall Core samples shall be tested for their compressive strength, Marshall Stability and retained Marshall Stability tests. The failure pattern of Marshall Specimens under compression can be seen in **Photo A7 (d)**. The compression tests should be performed at a rate of loading of 1.8kN/sec. The beam specimens should be tested for their flexural strength as per ASTM C 78 guidelines. Minimum of three specimens should be tested in each case and the average results shall be recorded.

	
<p>(a) High voids Bituminous Slab specimen</p>	<p>(b) Flow Cone used for Flow Value Measurement</p>
	
<p>(c) Grouted Beam sample</p>	



**Photo A7 of Preparation and Testing of CGBM Samples**

For having the actual field performance study of CGBM, two trial sections were laid in Surat city, Gujarat. The CGBM layer was laid as resurfacing course over existing bituminous surface on which approximately 650 CVPD traffic is plying. Further, the laboratory test results of field core samples (shown in **Photo A8 (a) & (b)**) were found to be close to the values determined on the laboratory prepared samples. The test results of field core samples are given in **Table A2**. The CGBM surface was also checked for their skid resistance using British Pendulum Tester (BPN instrument) as per ASTM E303.



**Photo A8 Field core samples extracted from the test sections**

**Table A2 Mechanical Strength Values of Field Core Samples (CGBM Gr-II)**

Sample No.	ITS, MPa	Resilient Modulus, MPa		
	@ 25°C	@ 25°C	@ 35°C	@ 45°C
Field Cores	1.80	17936	13089	9963

**Table A3 Test Results for the Three Gradations considered for CGBM (Gr-I, II, III)**

Sr No.	Properties	Units	Test Method	Test Results & Findings	
				Gr I & II (study by CSIR-CRRI)	Gr III (study by other premier laboratory)
1	<b>High Voids Bituminous Mix</b>				
1.1	Aggregate Grading	-	-	SD 19 & SD 13 (As per MoRTH)	OGFC (As per South African OGFC)
1.2	Binder content (VG30)	%	-	3-3.5 (ASTM D6390)	3.5
1.3	Air Voids in Mix	%	ASTM D3203	30-35	30
2	<b>Grout Material</b>			Jointly developed by CRRI & Industry Partner	Cementitious Flowable Grout
2.1	Grade of Cement	-	IS 12269	-	OPC 53
2.2	Fly ash	-	IS 3812 Part 2	-	Passing
2.3	<b>Properties of Grout</b>				
2.3.1	Initial Setting Time	hrs	IS 4031 Part 5	4	5.3
2.3.2	Final Setting Time	hrs	IS 4031 Part 5	7	7.5
2.4	Compressive Strength @28 Days	N/mm <sup>2</sup>	-	60 (IS 4031 Part 6, 50 cm <sup>2</sup> Face Area)	40-100 (ASTM C109, 50*50*50 mm)
2.5	Flexural Strength @ 28 Days	N/mm <sup>2</sup>	-	5.4	10 (IS 4031 Part 8, 160*40*40 mm)
2.6	Fluidity	sec	-	45 - 50 (Marsh Flow Cone)	23 (ASTM C 939)
3	<b>CGBM Composite</b>			Gr-II & Grout	Gr-III & Grout
3.1	Voids in CGBM @ 7 Days	%	ASTM D 3203	2.2 (using Micro-CT Imaging Technique)	2.86
3.2	Full Depth Grouting	%	Visual Inspection	>98	>95

Sr No.	Properties	Units	Test Method	Test Results & Findings	
				Gr I & II (study by CSIR-CRRI)	Gr III (study by other premier laboratory)
3.3	Compressive Strength @ 28 Days	N/mm <sup>2</sup>	-	5.5 (ASTM C39, Gyratory Samples of 100 mm dia. & 180 mm height)	10.5 (Marshal Samples of 100mm dia. & 60mm height)
3.4	Resilient Modulus @ 28 days at 35°C	N/mm <sup>2</sup>	ASTM D4123/ ASTM D7369	15000 (ASTM D4123)	12000 (ASTM D7369)
3.5	Flexural strength @ 28 days	N/mm <sup>2</sup>	ASTM C78	2.2 (Sample Size 150*50*50 mm)	2.85 (Sample Size 180*60*60 mm)
3.6	Marshal Stability @ 28 days	kN	ASTM D6927	114	45
3.7	ITS @28 Days at 35°C	N/mm <sup>2</sup>	ASTM D6931	1.53	1.03
3.8	Retained Stability@28 Days at 60°C	%	MoRTH specification	96	94
3.9	Retained ITS at 28 Days	%	AASHTO T283/ASTM D7870	98 ASTM D7870	-
3.10	CGBM layer thickness for trial section	mm	-	40	-
3.11	Opening to traffic	-	-	After 24 hours	-
3.12	Skid resistance	BPN	ASTM E303	60 in wet & 70 in dry condition	55 in wet condition

## OUTLINE OF ASTM C29 FOR DETERMINATION OF DRY AGGREGATE AIR VOIDS

### A. Scope and Summary of Test

This method covers the determination of bulk density (unit weight) of aggregate in a specified compacted condition and calculation of voids between aggregate particles based on this determination. The amounts of calculated voids are used in the mix design of CGBM. Only the dry rodded compaction is covered in this outline of the test method.

### B. Testing Equipment

1. Balance or scale accurate up to 0.1 percent of the test load.
2. Tamping rod: a round, straight steel rod, 16 mm (5/8 inch) in diameter and approximately 600 mm in length. Tamping end shall be rounded to a hemispherical tip with a diameter of 16 mm.
3. A sturdy, cylindrical metal measure with a capacity of 10 liters. The height and diameter of the measure should be approximately equal.
4. Shovel or scoop for filling the measure with aggregate.
5. Piece of glass plate of 6 mm thickness and at least 25 mm larger than the diameter of the measure.

### C. Testing Procedure

1. Calibrate the measure and determine its capacity in  $\text{mm}^3$  by filling it with water and covering with glass plate to eliminate air bubbles and excess water. Determine the mass of water in the measure. Calculate the volume of the measure (V), by dividing the mass of water by its density.
2. Use the dry rodding procedure to place and compact the oven-dry aggregates in the measure. Fill the measure 1/3 full with aggregate and level the surface with fingers. Rod the layer of the aggregate with 25 strokes of the tamping rod evenly distributed over the surface. Fill the measure 2/3 full, level with fingers and rod as above again. Finally, fill the measure slightly overflowing the measure and rod again as before. Level the surface of aggregate with fingers in such a way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the measure.
3. Determine the mass of the measure plus its contents and the mass of the measure alone and record the values to the nearest 0.05 kg.

4. Calculate the unit weight of the aggregate by the dry rodding procedure as follows:

$$M = (G - T) / V$$

Where,

- $M$  = bulk density of the aggregate in dry rodded condition, kg/m<sup>3</sup>  
 $G$  = mass of the measure plus aggregate, kg  
 $T$  = mass of the measure, kg  
 $V$  = volume of the measure, m<sup>3</sup>

#### D. Calculation

Calculate the void content in the aggregate using the bulk density determined above, as follows:

$$\% \text{ Voids} = 100 [(S \times W) - M] / (S \times W)$$

Where,

- $M$  = bulk density of the aggregate, kg/m<sup>3</sup>  
 $S$  = bulk specific gravity (dry basis)  
 $W$  = density of water, 998 kg/m<sup>3</sup>

## OUTLINE OF ASTM D 6390 FOR DETERMINATION OF DRAINDOWN CHARACTERISTICS IN UNCOMPACTED ASPHALT MIXTURES

### A. Scope and Summary of Test

This method determines the amount of drain down in an uncompacted asphalt mixture sample when the sample is held at elevated temperatures, which are encountered during the production, transportation, and placement of the mixture. This test is especially applicable to open-graded asphalt mixtures (such as open-graded friction course) and gap-graded mixtures such as Stone Matrix Asphalt (SMA). A fresh sample of the asphalt mixture (either made in the laboratory or from an asphalt plant) is placed in wire basket. The wire basket is hung in a forced draft oven for one hour at pre-selected temperature. A catch plate of known mass is placed below the basket to collect material drained from the sample. The mass of the drained material is determined to calculate the amount of draindown as a percentage of the mass of the total asphalt mix sample.

### B. Testing Equipment

1. Forced draft oven, capable of maintaining temperatures in a range of 120 to 175°C with +/- 2°C of the set temperature.
2. Plates to collect the drained material.
3. Standard wire basket meeting the dimensions is shown in **Photo 1**. A standard 6.3 mm sieve cloth shall be used to make the basket. The dimensions shown can vary by +/- 10 percent.
4. Balance readable to 0.1 gram.

### C. Testing Procedure

1. For each mixture to be tested, the draindown characteristics shall be determined at two temperatures: at the anticipated plant production temperature and at a temperature 10°C higher than the anticipated production temperature. Duplicate samples shall be tested at each temperature. Therefore, a minimum of 4 samples shall be tested.
2. Weigh the empty wire basket (Mass A).
3. Place in the wire basket 1200 +/- 200 grams of fresh, hot asphalt mixture (either prepared in the laboratory or from an asphalt plant) as soon as possible without losing its temperature. Place the mix loosely in the basket without consolidating it. Determine the mass of the wire basket plus sample to the nearest 0.1 gram (Mass B).
4. Determine the mass of the empty plate to be placed under the basket to nearest 0.1 gram (Mass C).
5. Hang the basket with the mix in the oven preheated to a selected temperature. Place the catch plate beneath the wire basket. Keep the basket in the oven for 1 hour +/- 5 minutes.

6. Remove the basket and catch plate from the oven. Let cool to ambient temperature. Determine the mass of the catch plate plus the drained material to the nearest 0.1 gram (Mass D).

**D. Calculation**

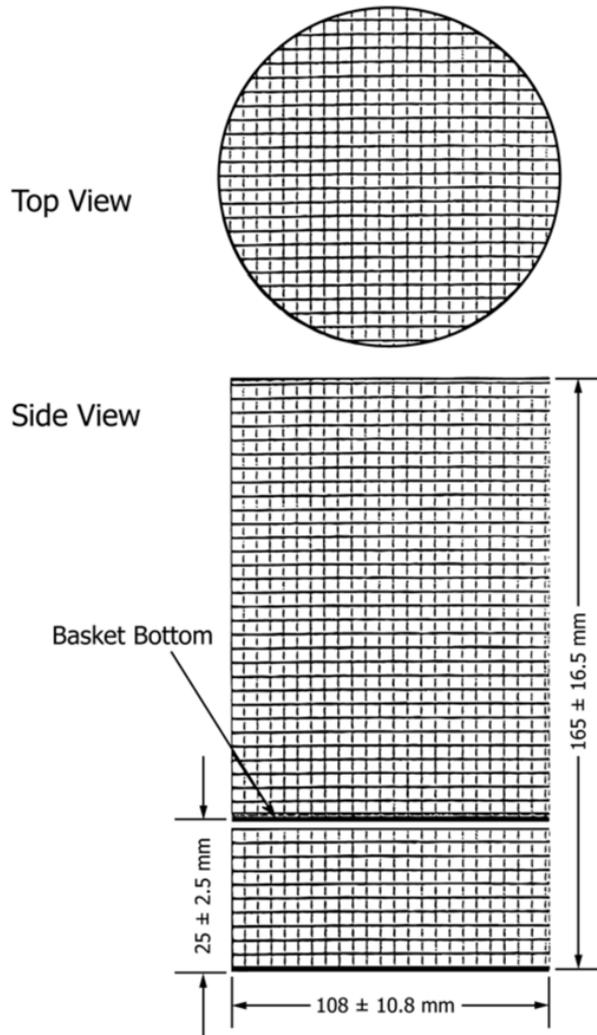
Calculate the percentage of mixture which drained to the nearest 0.1% as follows:

$$\text{Draindown (\%)} = [(D - C) / (B - A)] \times 100$$

Where,

- A = mass of the empty wire basket, g
- D = mass of the wire basket plus sample, g
- C = mass of the empty catch plate, g
- D = mass of the catch plate plus drained material, g

Average the two draindown results at each temperature and report it to nearest 0.1 percent.



**Photo 1 Wire Basket Assembly for Draindown Test**

## OUTLINE OF ASTM D 2041 FOR THEORETICAL MAXIMUM SPECIFIC GRAVITY AND DENSITY OF BITUMINOUS PAVING MIXTURES

### A. Scope and Summary of the Test Method

This test method covers the determination of the theoretical maximum specific gravity and density of uncompacted bituminous paving mixtures at 25°C. The theoretical maximum specific gravity ( $G_{mm}$ ) is used: (a) to calculate air voids in compacted bituminous mixtures, (b) to calculate the amount of bitumen absorbed by the aggregate, and (c) to provide target value for the compaction of paving mixtures in the field. A sample of loose paving mixture is placed in a tared vacuum vessel. Water is added to completely submerge the sample. A specified amount of vacuum is gradually applied to remove the air bubbles entrapped between asphalt mix particles. After the vacuum is released, the volume of the sample of the void less paving mixture is obtained by either immersing the vacuum container with the sample in a water bath or weighing or by filling the calibrated vacuum container level full of water and weighing in air.

### B. Testing Equipment

1. Container (either a or b below)
  - a. Vacuum bowls - Either a metal or plastic bowl with a diameter ranging from 180 to 260 mm and a bowl height of at least 160 mm. The bowl shall be equipped with a stiff, transparent cover fitted with a rubber gasket and a connection for the vacuum line. The hose connection shall be covered with a small piece of fine wire mesh to minimize loss of any fine material from the mix.
  - b. Vacuum flask - To be used for weighing in air only: A thick-walled volumetric glass flask with a capacity of approx. 4000 ml, fitted with a rubber stopper with a connection for the vacuum line. The hose connection shall be covered with a small piece of fine wire mesh to minimize loss of any fine material from the mix.
2. Balance capable of being read to the nearest 0.1 gram. If weighing is to be done under water, a suitable suspension arrangement shall be provided for weighing the sample while suspended from the centre of the balance.
3. Vacuum pump, capable of evacuating air from the vacuum container to a residual pressure of 4.0 kPa (30 mm of Hg) or less. Provide a suitable trap between the pump and container to minimize water vapour entering the vacuum pump.
4. Residual pressure manometer or calibrated absolute pressure gauge with a bleed valve to adjust the vacuum level.
5. Water bath capable of maintaining a constant temperature of 25 +/- 1°C and suitable for immersion of the suspended container.

**C. Calibration of Containers**

1. Bowls: Determine the mass (B) of the container immersed in water at  $25 \pm 1^\circ\text{C}$ . If the bowl is used for weighing in air, place the volumetric lid on the bowl while under water. Remove the water-filled bowl with the lid in place and dry prior to determining the combined mass of the bowl, lid and water. Repeat 3 times and average the 3 masses. Designate the average mass as D.
2. Flasks: Calibrate the volumetric flask by accurately determining the mass of the flask filled with water at  $25 \pm 1^\circ\text{C}$ . Use a glass cover plate to ensure the flask is completely full.

**D. Testing Procedure**

1. Separate the particles of the loose paving mixture (while it is warm) by hand so that the particles are not larger than about 6 mm and don't fracture the aggregates. Place the mix sample directly into the tarred bowl or flask. Weigh the container with the sample and designate the net mass of the sample only as A. (Note: The minimum sample size shall be 1500g for mixes with nominal maximum aggregate sizes of 12.5 mm or smaller; and shall be 2500g for mixes with nominal maximum aggregate sizes from 19 to 25 mm).
2. Add sufficient water at  $25^\circ\text{C}$  to cover the sample completely. Place the cover (bowl) or stopper (flasks) on the containers.
3. Place the container with the sample and water on a mechanical agitation device or agitate manually at frequent intervals (2 to 3 minutes). Begin removing entrapped air by gradually applying vacuum and increasing the vacuum pressure until the residual manometer reads  $3.7 \pm 0.3 \text{ kPa}$  ( $27.5 \pm 2.5 \text{ mm of Hg}$ ). After achieving this level within 2 minutes, continue the vacuum and agitation for  $15 \pm 2$  minutes. Gradually release the vacuum with the bleed valve.
4. Weighing in water- Suspend the bowl (without lid) and contents in water for  $10 \pm 1$  minutes and then determine mass. Designate the mass under water of the bowl and sample as C.
5. Weighing in air
  - a. Bowl – Submerge the bowl and sample slowly in the  $25 \pm 1^\circ\text{C}$  water bath. Keep it there for  $10 \pm 1$  minute. Immerse the lid in water and slide it onto the bowl without removing water from the bowl so that no air is trapped inside the bowl. Remove the bowl with the lid in place from the water bath. Dry the bowl and lid with a dry cloth. Determine the mass of the bowl, sample and lid and designate it as E.
  - b. Flask – Fill the flask slowly with water ensuring not to introduce any air into the sample. Place the flask in water bath for  $10 \pm 1$  minute to stabilize the temperature at  $25^\circ\text{C}$  without submerging the top of the flask. Completely fill the flask with water using a cover plate without entrapping air beneath the cover plate. Wipe the exterior of the flask and cover plate. Determine the mass of the flask, plate and its contents completely filled with water. Designate this mass as E.

6. Calculations: Calculate the maximum specific gravity of the sample of loose paving mixture as follows:

**a. Bowls Used Under Water Determination**

$$G_{mm} = A / [A - (C - B)]$$

Where,

- $G_{mm}$  = max specific gravity of the mixture  
A = mass of dry sample in air, g  
B = mass of bowl under water, g  
C = mass of bowl and sample under water, g

**b. Bowls in Air Determination**

$$G_{mm} = A / [A + D - E]$$

Where,

- $G_{mm}$  = max specific gravity of the mixture  
A = mass of dry sample in air, g  
D = mass of lid and bowl under water at 25°C, g  
E = mass of lid, bowl and sample and water at 25°C, g

**c. Flask Determination**

$$G_{mm} = A / [A + D - E]$$

Where,

- $G_{mm}$  = max specific gravity of the mixture  
A = mass of dry sample in air, g  
D = mass of cover plate and flask filled with water at 25°C, g  
E = mass of flask, cover plate, sample and water at 25°C, g

**OUTLINE OF ASTM C939 FOR MEASURING  
THE FLOW VALUE OF GROUT USING FLOW CONE**

**A. Scope and Summary of Test**

This test method covers a procedure, used both in the laboratory and in the field, for determining the time of efflux of a specified volume of fluid grout through a standardized flow cone. The measured time of efflux of a specified volume of grout from a standardized flow cone is termed as Flow Value of grout, which directly relates to the Flow-ability of the grout.

**B. Apparatus**

1. Flow Cone, with dimensions as shown in **Fig. 1**.
2. Receiving Container of minimum 2000 mL capacity.
3. Ring Stand or other device, capable of supporting the flow cone in a vertical, steady position over the receiving container.
4. Level
5. Stop Watch, least reading of not more than 0.2 s.
6. Grout Mixer, conforming to Practice C 938.

**C. Procedure**

1. Moisten the inside of the flow cone by filling the cone with water and, 1 min before introducing the grout sample, allow the water to drain from the cone. Close the outlet of the discharge tube with a finger or a stopper.
2. Introduce the grout into the cone until the grout surface rises to contact the point gauge, start the stop watch, and simultaneously remove the finger or stopper. Stop the watch at the first break in the continuous flow of grout from the discharge tube.
3. The test for time of efflux shall be made within 1 min of drawing of the grout from the mixer or transmission line.

**D. Result**

Average time of efflux to nearest 0.2 seconds is reported as the Flow Value of grout along with time interval from completion of mixing at which the test was made.

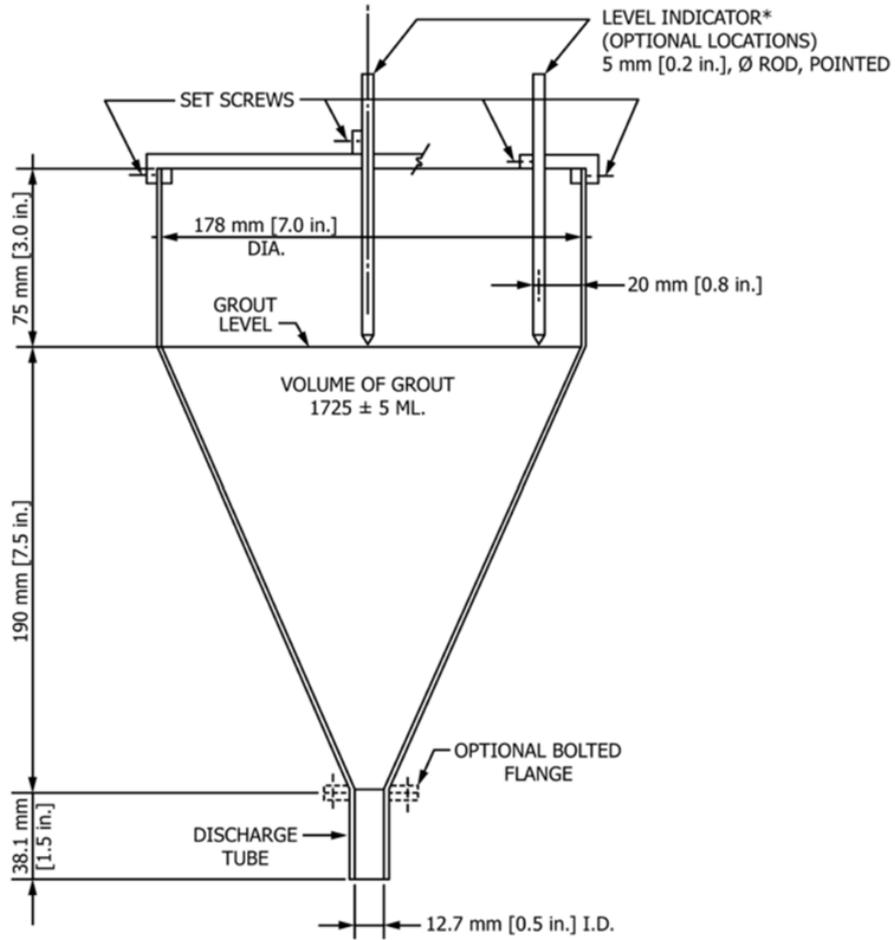


Fig. 1 Cross section of Flow Cone

### **CONSTRUCTION OF CGBM PAVEMENTS**

Different stages for construction of CGBM are described below. The summarized stages of CGBM construction at field are also depicted in **Photo 2(a)** to **Photo 2(e)**.

1. A tack coat of bitumen or bitumen emulsion should be applied as per the MoRTH specifications, before the construction of High Voids Bituminous Mix. If only aggregate layer such as WMM or WMM is the base, prime coat shall be applied.
2. Aggregates and bitumen should be heated and mixed in a hot mix plant.
3. The hot High Voids Bituminous Mix is then laid with Paver and then lightly compacted with smooth wheel Static Roller. Normally 4 to 6 passes are given.
4. When the temperature of the paved high voids bituminous mix drops down to ambient temperature (say near about 50 to 60°C), then the compacted bituminous surface is ready to be grouted.
5. The cement grout should preferably be prepared in Pan Mixer so that all ingredients gets get fully intermixed. If patented intimately mixed commercial dry powder is available in market, the pan mixer may be replaced with any simple blending equipment to produce liquid grout slurry.
6. Once the grout slurry is thoroughly mixed and has achieved the desired Flow Value, then the cementitious grout slurry can be applied on the prepared high voids bituminous surface. Application of cementitious grout can be done manually or by mechanical means over the high voids bituminous surface. Sweeping/Squeezing or other such simple techniques can be adopted for this purpose. The applied grout should be able to automatically flow into the voids of the bituminous surface under the effect of gravity alone. The edges of the bituminous layer should necessarily be covered with any suitable material like fly ash in order to restrict the outflow of the grout slurry. Grout application work should not be executed in rainy or snowy environment.
7. To improve the surface roughness, the grouted surface can be mechanically/ manually broomed to create texture on the surface.
8. Moist curing needs to be done in accordance with IRC:44. Curing by water spray can also be carried out for seven days, even with traffic in operation. If polymer based grout is used, curing for at least twenty four hours must be done.

No construction joints are required in CGBM pavements. Looking to needs of urban area the CGBM roads can be opened to light traffic within 24 hrs, provided that compressive strength of at least 3MPa for the composite CGBM layer is achieved. Cores should be taken at random places and be examined to check the full depth penetration of grout into the high voids bituminous layer. The skid resistance should be evaluated using British Pendulum Tester and the minimum skid resistance value should be 60 BPN for dry condition and 55 BPN for wet condition.

There is availability of readymade commercial products for grouting with strength of up to 90 MPa at 7-8 days. These grouts can be used in CGBM works, if they are found suitable and satisfying the strength and flowability requirements. Leachability test may also be done to check whether the chemicals contain any harmful components.



Photo 2 (a) to (f) Stages of CGBM Construction at Site

## REFERENCES

1. Specification on Construction and Evaluation of Resin Modified Pavement (RMP), 1996, Randy C. Alrich and Gary L. Anderton, Dept. of Army, Waterways Experiment Station, Corps of Engineers, Mississippi, USA.
2. Code of Practice for Grouted Macadam Surfacing, RSTA, ADEPT, UK, March 2017.
3. G. Bharath, Manoj Shukla, M. N. Nagabushana, Satish Chandra & Amit Shaw, "Laboratory and field evaluation of cement grouted bituminous mixes", Journal of Road Material and Pavement Design, (2019).
4. Design & Performance Evaluation of Cement Grouted Bituminous Mix for Urban Roads. Research Report submitted by CRRI under CSIR - Fast Track Translation (FTT) Project, July 2018.
5. Manoj Shukla, M.N. Nagabushana, Sagar Verma "Cement Treated Grouted Macadam-A New Concept of Long-Lasting Pavement" Conference on Sustainable Asphalt Pavement for Developing Countries, CRRI, March 11-12, 2016.
6. Al-Qadi, I., Gouru, H., and Weyers, R. E., Asphalt Portland Cement Concrete Composite: Laboratory Evaluation, Journal of Transportation Engineering, 120(1), 1994, pp.94-108.
7. Anderton, G. L., 2000, Engineering Properties of Resin Modified Pavement (RMP) for Mechanistic Design, Geotechnical Laboratory, U. S. Army Engineering Research and Development Center, ERDC/GL TR-00-2. <<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA376263>>, July 12, 2013.
8. ASTM C109, Standard Test Method for Compressive Strength Hydraulics Cement Mortar 50 mm Cube, ASTM International, West Conshohocken, 2010.
9. ASTM C 476-10, Standard Specification for Grout for Masonry, ASTM International, West Conshohocken, 2010.
10. ASTM C937-10, Standard Specification for Grout Fluidifier for Preplaced Aggregate Concrete, ASTM International, West Conshohocken, 2010.
11. CRRI, Evaluation of ACC Marg Overlaid Road Sections, report submitted by Central Road Research Institute, sponsored by Associated Cement Companies India Pvt. Ltd., Research and Consultancy Directorate, Thane, 2002.
12. IS:73, Specifications for Paving Bitumen, Bureau of Indian Standards, New Delhi, 2006.
13. IS:12269, Specification for 53 Grade Ordinary Portland Cement, Bureau of Indian Standards, New Delhi, 2008.
14. IS:9284, Method of Test for Abrasion Resistance of Concrete, Bureau of Indian Standards, New Delhi 2007.
15. IS:2386, (Part IV), Friction tester, Bureau of Indian Standards, New Delhi, 1963.
16. IRC:SP:53, "Guidelines on Use of Modified Bitumen in Road Construction", Indian Roads Congress, New Delhi.

17. Gawedziniki, M., (2008) Evaluation of Semi-Flexible (Resin Modified) Pavement 12008-1, Illinois Department of Transportation Bureau of Materials and Physical Research.
18. Specifications for Roads and Bridge Works, 2013, Fifth Revision, Ministry of Road Transport and Highways, Government of India, published by IRC.
19. Oliveira, J. R., Zoorob, S. E., Thom, N. H., and Pereira, P. A., (2007) A simple approach to the Design of Pavements incorporating Grouted Macadams, 4<sup>th</sup> International Conference Bituminous Mixtures and Pavements, Thessaloniki, Greece.
20. Oliveira, J. R., Thom, N. H., and Zoorob, S. E., (2006) Fracture and Fatigue Strength of Grouted Macadams, 10<sup>th</sup> International Conference on Asphalt Pavements, Quebec City, Canada, vol. 1, pp. 225-34.
21. Oliveira J. R., Sangiorgi C., Fattorini G., and Zoorob S. E., (2009) Investigating the fatigue performance of grouted macadams, Transport, 162(TR2), pp. 115-123.
22. Oliveira, J. R., Thom, N. H., and Zoorob, S. E., (2008) Design of Pavements Incorporating Grouted Macadams, Journal of Transportation Engineering, ASCE, 134(1), pp. 7-14.
23. Suresha, S. N., Ravi Shankar, A. U., George, V., Investigation of Porous Friction Courses and Mixes: a brief over review, Indian Highways, July 2007.
24. Wu, D. Q., The Semi-Rigid Pavement with Higher Performances for Roads and Parking Aprons, CAFEO 29, Sustainable Urbanization – Engineering Challenges and Opportunities, November 27-30, 2011, Brunei Darussalam, pp.1-7.
25. Mani anta Raju (2013), 'Evaluation of Performance of Cement Grouted Bituminous Mixes' M.Tech Thesis, IIT Kharagpur.
26. Grouted Macadam: Successful Technology for Rehabilitation of Bituminous Roads by V.V. Deshmukh, A.K. Chatterjee.
27. The Semi-Rigid Pavement with Higher Performances for Roads and Parking Aprons Dong Qing Wu, Daud, Yanli Zhang Chemilink Technologies Group, Singapore hq@chemilink.com.



**(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/Manual, etc. from the date specified therein)**