

श्यामा प्रसाद मुखर्जी पत्तन, कोलकाता Syama Prasad Mookerjee Port, Kolkata शिविल इंजीलियरिंग विधाग/Civil Engineering Department मुख्य अभियंता कोलकाता का कार्यालय / Office of the Chief Engineer 6, फ़ॉर्ली प्लेस(फ़ॉर्ली वेयरहाउस)/6, Fairlie Place (Fairlie Warehouse) कोलकाता -700 001 /Kolkata - 700 001 दुरमाष/ Phone: 033-7101-2363/2013, e-mail:ce@kolkataporttrust.gov.in



No. SMPK/KDS/CIV/T/2829/662

Dated: 14.06.2024

# Addendum-II

Ref: NIT No .:- SMPK/KDS/CIV/T/2829/11

Dated: 08.03.2024

Tender Id No .:- SMPK/KDS/CIV/T/2829/11

**Name of Work:** - Revamping/up-gradation of 6(six) roads in port operational areas of KDS under Syama Prasad Mookerjee Port , Kolkata.

In reference to the above mentioned NIT, following are further added:

- 1. New clauses added under "SPECIAL CONDITIONS OF CONTRACT
- 2. Joint Venture Formats as Appendix-1 to 7
- 3. Reply / response of SMPK to the Pre-bid queries (corrected)
- Corrigendum V(supersedes Corrigendum IV)

All other terms & conditions shall be as per original bid document and subsequent Addenda, Corrigenda.

Superintending Engineer –Contract

For मुख्य अभियंता / Chief Engineer

No:- SMPK/KDS/CIV/T/2829/662

dated14/06/2024

# ADDENDUM-II

# <u>T0</u>

# TENDER DOCUMENT

# VIDE

# NIT.No:-SMPK/KDS/CIV/T/2829/11 dated 08/03/2024

Sub :- Revamping/ up-gradation of 6(six) roads in port operational areas of KDS

under Syama Prasad Mookerjee port, Kolkata

New clauses added under "SPECIAL CONDITIONS OF CONTRACT"

## 57. Deployment of Technical Staff :

Minimum Civil technical staff to be deployed for supervision and execution of work:

SI. No.	Position	Education Qualification and Experience	Minimum number of personnel to be deployed
1	Project Engineer	Graduate in Civil Engineering. Minimum 5 years of experience in execution of Road Works.	01(One)
2	Site Engineer	Diploma in Civil Engineering. Minimum 5 years of experience in execution of Road Works.	03(Three)

#### Note:-

1. Bidder needs to submit authorization letter for the aforesaid Engineers and supporting educational and experience document during techno-commercial bid. During execution, if the declared technical staff(s) are to be replaced with another staff, prior intimation has to be given to Engineer In-charge for due approval along with aforementioned supporting documents.

2. Additionally, the contractor needs to deploy other technical staff, labours etc. as required for smooth and timely completion of work, whose details are to be furnished positively in terms of SI. No. xi of page 16 under MODE OF SUBMISSION OF BID.

#### 58.0 JOINT VENTURE/CONSORTIUM AND OTHER FORMS OF ASSOCIATION

**58.1 Bidders:** - The following types of entities fulfilling the Pre-Qualification Criteria shall be eligible to participate as Bidder/ Consortium Bidder under this Tender Document (hereinafter "**Bidders**"):

- (i) A proprietorship firm owned / operated / managed exclusively by an Indian national domiciled in India;
- (ii) A partnership firm duly registered under The Indian Partnership Act, 1932.
- (iii) A limited liability partnership incorporated under The Limited Liability Partnership Act, 2008.
- (iv) A company within the meaning of Companies Act, 2013.

#### 58.2 For Consortium Bidder(s):

- (i) All the constituent members of a Consortium Bidder must fall under any of the categories stated in sub-clause(i)to (iv)of clause 58.1 above;
- (ii) Where a Consortium Bidder is declared to be the L1 Bidder, members of such Consortium Bidder must incorporate a joint venture entity or a special purpose vehicle, either as a limited liability partnership under The Limited Liability Partnership Act, 2008 or a company within the meaning of Companies Act, 2013and such joint venture entity / special purpose vehicle shall be the Contractor for the purposes of the Works; Provided however that the members of such Consortium Bidder shall continue to be jointly and severally liable for the performance of the joint venture entity / special purpose vehicle under the Contract.

Non-compliance with the aforesaid instructions shall be construed to be non-responsive acts of such unincorporated Consortium Bidder to the Tender Documents.

- 58.2.1. A Consortium Bidder shall not comprise of more than 3 (three) Bidders out of which the Bidder fulfilling the following requirements shall constitute the Lead Member of the Consortium Bidder:
  - (i) the Bidder shall be principally engaged in the business of allied activities;
  - the Bidder's credentials should contribute towards more than 50% (fifty percent) of the Rs. 17,61,86,881.70 (Rupees Seventeen crore Sixty One Lakh Eighty Six thousand Eight Hundred Eighty One and paisa Seventy only)estimated amount put to tender) Pre-Qualification Criteria (excluding GST) in a single contract.

The other members of such Consortium Bidder shall expressly authorize the Lead Member by way of valid and irrevocable power of attorney(s) to submit all necessary documents and undertakings in connection with the participation in the Tender and all such acts of the Lead Member shall be binding on the constituent members of the Consortium Bidder. The Lead Member of the Consortium Bidder shall submit certificates from practicing chartered accountants and/or its statutory auditor (if applicable) to the Tender Authority (as part of the Bid Documents) certifying due compliance of the Lead Member's qualifications, as stated above.

Notwithstanding anything contained herein or any other document, the Lead Member of a Consortium Bidder shall be liable for and responsible to the Tender Authority for all acts of the members of the Consortium Bidder.

- 58.2.2 In case of a Consortium Bidder, the Lead Member's credentials should contribute towards more than 50% (fifty percent) of the Pre-Qualification Criteria [Rs. 17,61,86,881.70 (Rupees Seventeen crore Sixty One Lakh Eighty Six thousand Eight Hundred Eighty One and paisa Seventy only)estimated amount put to tender)]and each of the remaining members of a Consortium Bidder shall contribute towards more than 25% (twenty-five percent) of the Pre-Qualification Criteria.
- 58.2.3. Members of a Consortium Bidder shall not be permitted to participate individually or as part of another Consortium Bidder, with respect to this Tender.
- 58.2.4. All the procedures mentioned hereinafter regarding the Bid submission and payment process shall be done by the Lead Member of the Consortium Bidder.
- 58.2.5. There shall not be any change in control (whether directly or indirectly) of any non-individual or juristic entity participating as a member of a Consortium Bidder post submission of the Bid Documents. In
- 58.2.6 Each member of a Consortium Bidder, participating in the Tender undertakes not to enter into any undisclosed agreement or understanding, whether formal or informal with other Bidder(s) with respect 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 Tender process.
- 58.2.7 Any form of bid rigging by any Bidder or any member of a Consortium Bidder including by way bid suppression, complementary bidding, bid rotation, sub-contracting, arrangements with shareholders or ownership interest holders of non-individual and juristic entities, etc. if discovered subsequently, shall result in immediate termination of the Awardto such Bidder or Consortium Bidder by the Tender Authority and the Tender Authority shall proceed against such defaulting Bidder or defaulting Consortium Bidder and its constituent members in the manner prescribed under the Tender Document and Applicable Laws.

## 58.3 PARTICIPATION AS A CONSORTIUM

In case a Bid is submitted by a consortium of Bidders ("Consortium Bidder"), the Lead Member of such Consortium Bidder shall provide (for itself and on behalf of the constituent members) or ensure the following:-

The Lead Member of the Consortium Bidder shall submit certificates from practicing chartered accountants and/or its statutory auditor (if applicable) to the Tender Authority (as part of the Bid Documents) certifying due compliance of the Lead Member's qualifications, as stated in clause 58.2.1.

Each member Bidder of the Consortium Bidder shall also submit certificates from practicing chartered accountants and/or their respective statutory auditor (if applicable) to the Tender Authority (as part of the Bid Documents) certifying due compliance of the respective member Bidder's qualifications.

All joint venture agreements, consortium agreements, technical collaboration agreements, financing agreements, etc. ("**Consortium Bid Documents**") which shall ensure that all member Bidders of the Consortium Bidder shall remain jointly and severally liable for implementation of the Works.

The Consortium Bid Documents shall explicitly set forth the scope and responsibilities of all the members of the Consortium Bidder in terms of financial and technical commitments/contribution.

Authorization in favour of the Lead Member of the Consortium Bidder shall be evidenced by a power of attorney duly signed by the members of the Consortium Bidder as per the format enclosed in the Tender Document.

- (i) The Consortium Bidder shall constitute a committee which shall be primarily responsible for all liaison activities with the Tender Authority and other regulators during the bidding process and tenure of the Works.
- (ii) The Consortium Bid Documents and the terms thereof shall remain valid and irrevocable for the entire term of the Works and also for an additional period of defect liability or till such time the SD BG is released by the employer. from completion of the Tender Period.
- (iii) The members of a Consortium Bidder shall have demonstrated to the satisfaction of the Tender Authority their respective financial soundness and adequacy of equipment, fleet, cash and cash equivalents to perform their respective obligations under the Tender, if awarded.
- (iv) The members of the Consortium Bidder shall be jointly and severally responsible to obtain all licenses, clearances, registrations, grants, approvals, concessions, permits, etc., in connection with their performances under the Tender and all compliances and obligations under such licenses, clearances, registrations, grants, approvals, concessions, permits, etc., shall also be the jointly and severally responsible of the members of the Consortium Bidder.
- (v) The members of the Consortium Bidder shall jointly and severally indemnify and keep indemnified the Tender Authority from any losses arising out of or in connection with their performances under the Tender and/or the Award of the Tender.

- (vi) The members of the Consortium Bidder shall undertake that no dispute inter se between them shall cause any stoppage or cessation of work under the Tender, if awarded. In case of recurring disputes between the members of the Consortium Bidder resulting in delay in timelines of the Works, the Tender Authority reserves the right to call for substitution of the Contractor, i.e., the Consortium Bidder who has been selected for the Works.
- (vii) None of the members of a Consortium Bidder should have been blacklisted by any Governmental or Regulatory Authority and none of members of the Consortium Bidder should be subject or have been subject to proceedings under anti-corruption laws, anti-dumping laws, trade laws and anti-foreign sanction laws and/ or has been involved in (on currently involved in) proceedings pertaining to bid rigging and cartelisation.
- (viii) Documents for and on behalf of members of a Consortium Bidder shall be submitted by the duly authorised Lead Member and it shall be the responsibility of the Lead Member alone to purchase/ legally procure the Tender Document for and on behalf of the members of the Consortium Bidder.
- (ix) It is clarified that an unsuccessful Bidder or any member of an unsuccessful Consortium Bidder shall not participate directly/ indirectly in the Works in any manner whatsoever, after the Award of the Tender has been made in favour of the Contractor.

## 58.4 TECHNICAL & FINANCIAL CAPABILITY.

The Bidder (whether a Consortium Bidder or not) must satisfy Pre-Qualification Criteria as stipulated in clause 58.1 & 58.2 hereinabove and other eligibility conditions, as mentioned in the Tender Document.

## 58.4.1 Assessment of eligibility:

i. In case of a Consortium Bidder, the Lead Member's credentials should contribute towards more than 50% (fifty percent) of the Pre-Qualification Criteria and each of the remaining members of a Consortium Bidder shall contribute towards more than 25% (twenty-five percent) of the Pre-Qualification Criteria. The Lead Member of the Consortium Bidder shall additionally fulfil the following criteria:

- 1. the Lead Member shall be principally engaged in the business of 'Similar Work' activities.
- 2. The Lead Member's credentials should contribute towards more than 50% (fifty percent) of the Pre-Qualification Criteria; and
- 3. The Lead Member's cash flows (to the exclusion of other member Bidders of the Consortium Bidder) or financial resources shall be sufficient to meet at least 50% (fifty percent) of the Annual Evaluated Contract Value ;
- ii. The Lead Member shall on behalf of itself and each of the Members of a Consortium Bidder, provide as part of the Bid Documents:
  - 1. a Power of Attorney as per format given at Appendix-1, authorizing the Lead Member to act on behalf of the members of the Consortium Bidder;

- 2. all information of the participant members in a Consortium Bidder, as applicable to a standalone Bidder;
- a statement of inter-se allocation of work and responsibilities between the members of the Consortium Bidder vis-àvis the Works;
- 4. a statement of overlapping responsibilities and work
- 5. a list indicating the extent of third party dependency;
- 6. Duly executed and stamped (with adequate stamp duty) a Joint Bidding Agreement (JBA) (substantiated in the form specified at **Appendix-5**, for the purpose of submitting Tender;
- 7. An undertaking to the effect that:
- A. Where a Consortium Bidder is declared to be the L1 Bidder, members of such Consortium Bidder must incorporate a joint venture entity or a special purpose vehicle, either as a limited liability partnership under The Limited Liability Partnership Act, 2008 or a company within the meaning of Companies Act, 2013, and such joint venture entity / special purpose vehicle shall be the Contractor for the purposes of the Works; Provided however that the members of such Consortium Bidder shall continue to be jointly and severally liable for the performance of the joint venture entity / special purpose vehicle under the Contract;
- **B.** There shall not exist any agreement, contract, deed, memoranda, etc. inter se the members of the Consortium Bidder, other than the Consortium Bid Documents and the Project Documents to be submitted to the Tender Authority;
- C. No scope of work shall be sub-contracted to any Person suffering from "Conflict of Interest" or whose Bid has been rejected by the Tender Authority;
- D. No change in constitution or shareholding of the Consortium Bidder shall be permitted till expiry of Tender Period.
- E. Each of the members of the Consortium Bidder shall continue to perform their obligations under the Project Documents regardless of any inter-se dispute or any dispute with the Tender Authority, and such pending disputes shall not result in delaying, stoppage or cessation of Works;
- F. The members of the Consortium Bidder shall be jointly and severally liable to obtain necessary clearances, permissions, licenses, approvals, consents, no-objections, etc. as may be required for the Works;
- **G.** Each member of a Consortium Bidder shall obtain separate and distinct security clearances from the Government of India and shall be subject to the same set of restrictions as provided therein.
- **H.** The members of a Consortium Bidder shall be jointly and severally liable to the Tender Authority in connection with the Tender and the Works .
- I. The Tender Authority shall have the right to call for substitution of the Contractor in case of recurring disputes between the members of the Consortium Bidder resulting in delay in the timelines of the Works or there being recurring events of default under the Project Documents.

## **58.5 CONFLICT OF INTEREST**

Any Bidder found to have a Conflict of Interest shall be disqualified. A Bidder shall be deemed to have a Conflict of Interest affecting the bidding process under this Tender, if:

- a) Where one Bidder is a related party of another Bidder (within the meaning of section 2(76) of the Companies Act, 2013) Provided however, that if the relationship between two Bidders as related parties, arises ONLY on account of common shareholding by the President of India/ Governor of any State/ All India Financial Institutions, Public Financial institutions, for the purposes of this Tender, it shall be so deemed that there is no conflict of interest between such Bidders.
- b) Where the significant beneficial ownership of two or more Bidders are vested in the same Person or same group of Persons. Provided however, that in Consortium Bidders, group entities of a Group of companies can participate as members of the same Consortium Bidder;
- c) A Bidder (or its Affiliates) receives or has received any direct or indirect subsidy, grant, concessional loan or subordinated debt from any other Bidder (or its Affiliates) or has provided any such subsidy, grant, concessional loan or subordinated debt to any other Bidder (or its Affiliates).
- d) In cases of Consortium Bidders, such conflict of interest shall be evaluated between the members of one Consortium Bidder and the members of another Consortium Bidder or any other Bidder. If any member of one Consortium Bidder is found to have conflict of interest with a member of another Consortium Bidder or any other Bidder, then it shall be so construed as if the two Consortium Bidders or Bidders have conflict of interest.
- e) A Bidder (including Consortium Bidder) shall be liable to be disqualified, if any regular legal, financial or technical adviser/ consultant of the Tender Authority in relation to the Tender is engaged by such Bidder (or any of its Affiliates and where there is a Consortium Bidders, by any member of the Consortium Bidder)) in any manner for matters related to or incidental to the Tender or the bidding process under this Tender. For the avoidance of doubt, this disqualification shall not apply where such regular legal, financial or technical adviser/ consultant of the Tender Authority was engaged by the Bidder (or any of its Affiliates) during the period preceding at least 1 (one) year from the date of issuance of the Tender Document and/or in connection with other projects/ assignments and for different nature of services.
- f) The Contractor (whether a Consortium Bidder or not, and in cases of Consortium Bidders, each member of the Consortium Bidder) shall not appoint any regular legal, financial or technical adviser/ consultant of the Tender Authority during the period of the Tender and also during the 3 (three) year period following the expiration of the Tender Period or termination of the Award of Tender in favour of the Contractor, whichever is earlier.
- g) In this regard, it must be borne in mind that suppression of such Conflict of Interest, if detected later, shall not absolve the Consortium Bidder / Bidder of its responsibility and appropriate action shall be initiated in terms of the provisions of this Tender Document, including but not limited to suspension, debarment, blacklisting, etc.

The Bidder(s) shall have valid documents as listed in various clauses of this tender document including those given at Clause 1 & 2)and submit the same in the manner as stipulated .

## PRO-FORMA OF BANK GUARANTEE FOR EARNEST MONEY (To be typed on a non-judicial stamp paper of Rs.50/-) Bank Guarantee No.....

Reference.....

Date:....

To Syamaprasad Mookerjee Port , Kolkata 15, Strand Road, Kolkata – 700 001.

Dear Sirs,

Whereas Board of Syamaprasad Mookerjee Port Kolkata, a Major Port Authority under Major Port Authorities Act, 2021 and the rules thereunder and statutory modification thereto having Registered Office at 15, Strand Road, Kolkata -700001 (hereinafter referred to as "Employer" which term will include its successors and assigns) have invited Tenders for [Name of work]. vide Notice Inviting Tender Reference..... dated and Whereas M/s.....(hereinafter referred to as "Bidder" which term will include its successors and assigns) is desirous of participating in the said tender.

And Whereas it is a condition in the tender documents that the BIDDER has to deposit Earnest Money with respect to the tender to the Employer, amounting to Rupees \_\_\_\_\_\_ or alternatively the Bidder is required to submit an unconditional Bank Guarantee from a Scheduled Bank irrevocable and operative till 30 days after the validity of the offer i.e 150 days from the date of opening of the Tender, for the like amount which amount is likely to be forfeited on the happening of contingencies mentioned in the tender documents.

And Whereas the Bidder desires to secure exemption from deposit of Earnest Money and has offered to furnish a Bank Guarantee for a sum of Rupees \_\_\_\_\_\_ to the Employer for the purpose of securing exemption from the deposit of Earnest Money.

NOW THEREFORE, we the.......Bank, a body incorporate constituted under the Banking Companies (Acquisition and Transfer of Undertakings) Act 1969 and having a branch office at.....(hereinafter referred to as "Bank" which terms shall include its successors, administrators, executors and assigns) do hereby undertake, agree and guarantee to pay on demand in writing from the Employer the amount of Rs.\_\_\_\_\_ (Rupees \_\_\_\_\_ only) to the Kolkata Port Trust without any demur, reservation or recourse.

We the aforesaid Bank, further agree that the Employer shall be the sole judge of and as to whether the Bidder has committed any breach or breaches of any of the terms and conditions of the tender and the extent of loss, damage, costs, charges, and expenses caused to or suffered by or that may be caused to or suffered by the Employer on account thereof the extent of the Earnest Money required to be deposited by the Bidder in respect of the said Tender document and the decision of the Employer that the Bidder has committed such breach or breaches and as to the amounts of loss, damage, costs, charges and expenses caused to or suffered by or that may be caused to or suffered by the Employer shall be final and binding on us.

This guarantee is valid during the validity period of the bid [which expression shall include any amendment / extension thereof] but the validity of this guarantee will be extended suitably until submission of ten percent [10%] of the Contract Price towards performance guarantee for satisfactory performance of the Contract in the event of the Bidder becoming the successful Contractor. The bank undertakes not to revoke this guarantee without the review consent of the Employer in writing.

We, the Bank further agree that the Guarantee herein contained shall remain in full force and effect until it is released by the Employer and change in the constitution, liquidation or dissolution of the Bidder, shall not discharge our liability guaranteed herein.

It is further declared that it shall not be necessary for the Employer to proceed against the Bidder before proceeding against the Bank and the Guarantee herein contained shall be enforceable against the Bank notwithstanding any security which the Employer may have obtained or shall obtain from the Bidder at the time when proceedings are taken against the Bank for whatever amount may be outstanding or unrealised under the Guarantee.

The right of the Employer to recover the said amount of Rs. \_\_\_\_\_\_ (Rupees \_\_\_\_\_\_\_ only) from us in manner aforesaid will not be affected in any way or suspended by reason of the fact that any dispute or disputes may be / are / have been raised by the said M/s......(Bidder) and / or that any dispute or disputes are pending before any authority, officer, tribunal or arbitrator(s) etc.

Notwithstanding anything contained herein above our liability under this guarantee is restricted to Rs. \_\_\_\_\_\_ and it shall remain in force upto and including \_\_\_\_\_\_ [the date after 165 days from the date of opening of the Tender] and shall be extended from time to time for such period, as may be desired by M/s \_\_\_\_\_\_ [name of Bidder] on whose behalf this guarantee has been given.

Date	Signature
Place	Name
	Designation
Witness	In presence of Bank's Common seal
1	Authorisation No
1.	Address
2	
2	Contact number

e-mail id .....

## Format For Power Of Attorney For Signing Of Tender

(To be executed before Notary Public on a Non-Judicial Stamp Paper of at least Rs 10)

Dated: \_\_\_\_\_

## POWER OF ATTORNEY

#### To whomsoever it may concern

Mr. \_\_\_ [Name of the Person(s)], residing at [Address of the person(s)], acting as (Designation of the person and name of the firm), and whose attested below, is hereby authorized on behalf signature is of [Name of the Tenderer (in case of a consortium, name of the lead member)] to sign the tender [(Tender No. .....and (Tender subject- ".....")] and submit the same and is hereby further authorized to provide relevant information/ document and respond to the enquiry's etc. as may be required by Syama Prasad Mookerjee Port, Kolkata (SMPK) in respect of the tender.

And I/ we hereby agree that all acts, deeds and things lawfully done by our said attorney shall be construed as acts, deeds and things done by us and I/ we undertake to ratify and confirm all and whatsoever that my / our said attorney shall lawfully do or cause to be done for me / us by virtue of the power hereby given.

(Attested signature of Mr	)	
For	(Name of the Tenderer / Consortium	Members
	with Seal)	

Note –

(In case of Consortium, representative of all members must sign)

#### **APPENDIX-2**

# Format For Power Of Attorney For Lead Member Of Consortium (To be executed before Notary Public on a Non-Judicial Stamp Paper of at least Rs 10)

#### **POWER OF ATTORNEY**

Whereas, it is necessary under the Tender Document for the members of the Consortium to designate one of them as the Lead Member with all necessary power and authority to do for and on behalf of the Consortium, all acts, deeds and things as may be necessary in connection with the Consortium's bid for the Tender and its execution.

#### NOW THEREFORE KNOW ALL MEN BY THESE PRESENTS

We, M/s. ...... having our registered office at ......, M/s......, M/s...... having our registered office at ....., M/s. ..... having our registered office at respective names and addresses of the registered office] (hereinafter collectively referred to as the "Principals") do hereby designate, nominate, constitute, appoint and authorize M/s. ...... having its registered office at ....., being one of the members of the Consortium, as the Lead Member and true and lawful attorney of the Consortium (hereinafter referred to as the "Attorney"). We hereby irrevocably authorize the Attorney to conduct all business for and on behalf of the Consortium and any one of us during the bidding process and, in the event the Consortium is awarded the Contract, during the execution of the contract, and in this regard, to do on our behalf and on behalf of the Consortium, all or any of such acts, deeds or things as are necessary or required or incidental to the pre-qualification of the Consortium and submission of its bid(s) for the tender, including but not limited to signing and submission of all applications, bids and other documents and writings, participate in Pre Bid and other conferences/meetings, respond to queries, submit information/ documents, sign and execute contracts and undertakings consequent to acceptance of bid(s) of the Consortium and generally to represent the Consortium in all its dealings with the Authority, and/or any other Government Agency or any person, in all matters in connection with or relating to or arising out of the Consortium's bid(s) for the tender and/or upon award thereof till the Agreement is entered into with the Authority.

AND hereby agree to ratify and confirm and do hereby ratify and confirm all acts, deeds and things lawfully done or caused to be done by our said Attorney pursuant to and in exercise of the powers conferred by this Power of Attorney and that all acts, deeds and things done by our said Attorney in exercise of the powers hereby conferred shall and shall always be deemed to have been done by us / Consortium.

#### Witnesses:

1.

2.

.....

(To be executed by all the members of the Consortium)

#### 'Appendix - 3

## **Profile Of The Tenderer**

- 1. (a) Name
  - (b) Country of incorporation
  - (c) Address of the corporate headquarters and its branch office(s), if any in India.
  - (d) Date of incorporation and commencement of business.
- 2. Brief description of the Company including details of its main lines of business and proposed role and responsibilities in connection with implementation of the tender.
- 3. Details of individual(s) of the tenderer (Lead Member in case of Consortium) who will serve as the point of contact/ communication with SMPK.
  - (a) Name
    (b) Designation
    (c) Company
    (d) Address
    (e) Telephone Number
    (Land & Mobile)
    (f) E-Mail Address
    (g) Fax Number

orized Signatory of the	e Tenderer:
1	orized Signatory of the

Name:

Designation		:
Company		:
Address		:
Telephone No.	:	
(Land & Mobile)		
Fax No.		:
Email Address	:	

- 5. In case of a Consortium:
  - a. The information above (1-4) should be provided for all the members of the consortium.
  - b. information regarding role of each member should be provided as per table below:

SI. No.	Name of Member	Role
1.		
2.		
3.		
4.		

Signature of Power of Attorney Holders .....

Name:
Designation:
Date :
Seal

#### Appendix - 4

# Syama Prasad Mookerjee Port, Kolkata

	Name of the similar project / work executed successfully.	Period of the project	Value of the project
Single Entity			
Consortium Member 1			
Consortium Member 2			

Instructions:

- 1. The single entity tenderer / each member of consortium should furnish its details in the appropriate column.
- 2. The description of each of the project shall have to be provided while giving the following details:
  - (a) Location of the project
  - (b) Contact details of the concerned projects
    - (i) Name of Contact Person(s)
    - (ii) Designation(s)
    - (iii) Address
    - (iv) Telephone/Mobile No.
    - (v) Fax
    - (vi) Email

Signature of Power of Attorney Holder(s).....

Name:
Designation:
Date:
Seal:

# **CERTIFIED BY**

Name of Chartered / Certified Accountant Firm
Registration Number & other details
Name of the Signatory
Signature
Designation
Date
Seal

### **APPENDIX-5**

# **Details Of Financial Capability Of The Tenderer**

(In Rs. Crore)

Applicant Type	Annual Financial Turn Over		
	Average on last 3 years		
Single entity Tenderer			
Consortium Member 1			
Consortium Member 2			
Consortium Member 3			
Consortium Member 4			
Please add more rows depending up	pon Consortium Members.		
Instructions:			
1. The Single Entity Tenderer/ e	ach members of Consortium should submit its		
details in the appropriate col	umn.		
Signature of Power of Attorney Hold	ler(s)		
Name			
Name:			
Designation:			
Date :			
Seal			
c	CERTIFIED BY		
Name of Chartered Accountant Firm			
Registration No. & other details			
Name of the Signatory			
Signature			
Designation			
Date			

## Joint Bidding Agreement

### (To be executed on Non-Judicial Stamp Paper of at least Rs. 60/-)

THIS JOINT BIDDING AGREEMENT is entered into on this the ...... day of ........... 20...

AMONGST

1. {..... Limited, a company incorporated under the Companies Act, 1956} and having its registered office at ...... (hereinafter referred to as the "First Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)

AND

2. {..... Limited, a company incorporated under the Companies Act, 1956} and having its registered office at ..... (hereinafter referred to as the "Second Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)

AND

3. {..... Limited, a company incorporated under the Companies Act, 1956 and having its registered office at ..... (hereinafter referred to as the "Third Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)}

AND

4. {...... Limited, a company incorporated under the Companies Act, 1956 and having its registered office at ...... (hereinafter referred to as the "Fourth Part" which expression shall, unless repugnant to the context include its successors and permitted assigns)} The above mentioned parties of the FIRST, SECOND, {THIRD and FOURTH} PART are collectively referred to as the "Parties" and each is individually referred to as a "Party"

## WHEREAS,

- (B) he Parties are interested in jointly bidding for the Project as members of a Consortium and in accordance with the terms and conditions of the tender document and other documents in respect of the work, and
- (C) It is a necessary condition under the tender document that the members of the Consortium shall enter into a Joint Bidding Agreement and furnish a copy thereof with the Offer.

## NOW IT IS HEREBY AGREED as follows:

- Definitions and Interpretations
   In this Agreement, the capitalised terms shall, unless the context otherwise requires, have the meaning ascribed thereto under the tender document.
- 2. Consortium
- 2.1 The Parties do hereby irrevocably constitute a consortium (the "Consortium") for the purposes of jointly participating in the Tendering Process for the Work.
- 2.2 The Parties hereby undertake to participate in the Tendering Process only through this Consortium and not individually and/ or through any other consortium constituted for this work, either directly or indirectly or through any of their Associates.

# 3. Covenants

The Parties hereby undertake that in the event the Consortium is declared the successful tenderer and awarded the contract, it shall incorporate a special purpose vehicle (the "SPV") under the Indian Companies Act 1956 for entering into an Agreement with the SMPK and for performing all its obligations as the successful tenderer in terms of the Agreement for the Project.

## 4. Role of the Parties

The Parties hereby undertake to perform the roles and responsibilities as described below:

(a) Party of the First Part shall be the Lead member of the Consortium and shall have the power of attorney from all Parties for conducting all business for and on behalf of the Consortium during the tendering process and till all the obligations of the SPV shall become effective;

- (b) Party of the Second part will be a technical member
- (c) Party of the Third part will be a financial member
- (d) Party of the Fourth part will be a operational member

[Note: Status of the members in (b), (c) and (d) are only illustrative. More/less parties may form the Consortium and changes may be made accordingly to the JBA]

5. Joint and Several Liability

The Parties do hereby undertake to be jointly and severally responsible for all obligations and liabilities relating to the work and in accordance with the terms of the tender document till completion of the contract.

- 6. Shareholding in the SPV
- 6.1 The Parties agree that the proportion of shareholding among the Parties in the SPV shall be as follows:
  First Party:
  Second Party:
  {Third Party:}
  {Fourth Party:}
- 6.2 The Parties undertake that a minimum of 26% (twenty six per cent) of the subscribed and paid up equity share capital of the SPV shall, at all times till completion of two years from the date of commencement of the contract, be held by the Parties of the First, {Second and Third} Part whose experience and net-worth have been reckoned for the purposes of pre-qualification in terms of the tender document.
- 6.3 The Parties undertake that they shall collectively hold at least 51% (fifty one per cent) of the subscribed and paid up equity share capital of the SPV at all times till completion of two years from the date of commencement of the contract.
- 7. Representation of the Parties

Each Party represents to the other Parties as of the date of this Agreement that:

- Such Party is duly organised, validly existing and in good standing under the laws of its incorporation and has all requisite power to enter into this Agreement with SMPK;
- (b) The execution, delivery and performance by such Party of this Agreement has been authorised by all necessary and appropriate corporate or governmental action and a copy of the extract of the charter documents and board resolution/ power of attorney in favour of the person executing this Agreement for the delegation of power and SMPK to execute this Agreement on behalf of the Consortium Member is annexed to this Agreement, and will not, to the best of its knowledge:
  - (i) Require any consent or approval not already obtained;
  - (ii) Violate any Applicable Law presently in effect and having applicability to it;
  - (iii) Violate the memorandum and articles of association, by-laws or other applicable organisational documents thereof;
  - (iv) Violate any clearance, permit, concession, grant, license or other governmental authorization, approval, judgment, order or decree or any mortgage agreement, indenture or any other instrument to which such Party is a party or by which such Party or any of its properties or assets are bound or that is otherwise applicable to such Party; or
  - (v) Create or impose any liens, mortgages, pledges, claims, security interests, charges or Encumbrances or obligations to create a lien, charge, pledge, security interest, encumbrances or mortgage in or on the property of such Party, except for encumbrances that would not, individually or in the aggregate, have a material adverse effect on the financial condition or prospects or business of such Party so as to prevent such Party from fulfilling its obligations under this Agreement;
- (c) this Agreement is the legal and binding obligation of such Party, enforceable in accordance with its terms against it; and
- (d) there is no litigation pending or, to the best of such Party's knowledge, threatened to which it or any of its Affiliates is a party that presently affects or which would have a material adverse effect on the financial condition or prospects or business of such Party in the fulfilment of its obligations under this Agreement.

## 8. Termination

This Agreement shall be effective from the date hereof and shall continue in full force and effect until the Financial Close of the contract is achieved under and in accordance with the terms of the tender, in case the contract is awarded to the Consortium. However, in case the Consortium is either not pre-qualified for the work or does not get selected for award of the contract, the Agreement will stand terminated in case the Tenderer is not pre-qualified or upon return of the Earnest Money by the SMPK to the Bidder, as the case may be.

## 9. Miscellaneous

- 9.1 This Joint Bidding Agreement shall be governed by laws of India.
- 9.2 The Parties acknowledge and accept that this Agreement shall not be amended by the Parties without the prior written consent of the SMPK.

# IN WITNESS WHEREOF THE PARTIES ABOVE NAMED HAVE EXECUTED AND DELIVERED THIS AGREEMENT AS OF THE DATE FIRST ABOVE WRITTEN.

SIGNED, SEALED AND DELIVERED	SIGNED, SEALED AND DELIVERED
For and on behalf of	For and on behalf of
LEAD MEMBER by:	SECOND PART by
(Signature)	(Signature)
(Name)	(Name)
(Designation)	(Designation)
(Address)	(Address)

### SIGNED, SEALED AND DELIVERED

For and on behalf of	For and on behalf of	
THIRD PART by:	FOURTH PART by	
(Signature)	(Signature)	
(Name)	(Name)	
(Designation)	(Designation)	
(Address)	(Address)	

In the presence of:

1.

2.

### Notes:

- 1. The mode of the execution of the Joint Bidding Agreement should be in accordance with the procedure, if any, laid down by the Applicable Law and the charter documents of the executants (s) and when it is so required, the same should be under common seal affixed in accordance with the required procedure.
- 2. Each Joint Bidding Agreement should attach a copy of the extract of the charter documents and documents such as resolution / power of attorney in favour of the person executing this Agreement for the delegation of power and SMPK to execute this Agreement on behalf of the Consortium Member.
- 3. For a Joint Bidding Agreement executed and issued overseas, the document shall be legalized by the Indian Embassy and notarized in the jurisdiction where the Power of Attorney has been executed.

Appendix - 7

## Covering Letter

Dated :

To,

Director, Marine Department Syama Prasad Mookerjee Port, Kolkata,

Dear Sir,

- 2 All information provided in the tender including Addenda and in the Appendices are true and correct and all documents accompanying such tender are true copies of their respective originals.
- 3. I/We shall make available to Syama Prasad Mookerjee Port, Kolkata (hereinafter referred to as SMPK) any additional information it may find necessary or require to supplement or authenticate the Tender
- 4. I/we acknowledge the right of SMPK to reject our tender without assigning any reason or otherwise and hereby waive our right to challenge the same on any account whatsoever.
- 5. I/we also certify the following
- a. I/we / any of the consortium member (as the case may be) have not been debarred by the Central/State Govt. or any entity controlled by them or any other legal authority for participating in any tender / contract / agreement of whatever kind
- b. I/we certify that in the last three years, I/We/any of the consortium members or our / their associates have neither failed to perform on any contract, as evidenced by imposition of a penalty by an arbitral or judicial authority or a judicial pronouncement or arbitration award, nor been expelled from any project or contract by any public authority/entity nor have had any contract terminated by any public authority / entity for breach on our part.
- 6. I/we declare that :

- a) I/we have examined and have no reservations to the Tender Document, including the Addenda issued by SMPK thereon.
- b) I/we hereby certify that we have taken steps to ensure that no person acting for us or on our behalf will engage in any corrupt, fraudulent or coercive practices to influence the evaluation process of the tender.
- 7. I/we understand that SMPK reserves the right to accept or reject any tender and to annul the tendering process and reject all tenders at any time without any liability or any obligation for such acceptance, rejection or annulment without assigning any reason thereof.
- 8. \_\_\_\_\_( Name of Tenderer) hereby undertakes that I/we will abide by the decision of SMPK in the matter of examination, evaluation and selection of successful tenderer and shall refrain from challenging or questioning any decision taken by SMPK in this regard.

Thanking you,

Yours faithfully,

Signature of Power of Attorney Holder(s)				
Name:				
Designation:				
Date :				

Seal

Reply / response of SMPK to the Pre-bid queries as received from the bidders in connection with the work of "Revamping/upgradation of 6 (six) roads in Port operational areas of KDS under Syama Prasad Mookerjee Port, Kolkata."

SI.	Request by the bidder	Response of SMPK	
No.			
	we also want to inform you that in the above mentioned tender the clause of Joint Venture is not provided thus we request you to please arrange to input the same so that we can able to participate the above mentioned tender.	Please refer to the Addendum No:- SMPK/KDS/CIV/T/2829/639 dated 11/06/2024.	
2	It is mentioned that Performance Security (PS) of 10% is required to be submitted on receipt of work award and Security Deposit of 5% will be deducted from each RA bill. This clause is not a standard practice and will put cash flow burden involving 15% of the project cost being retained by the Employer. Thus, we request you to kindly waive of further deduction of Security Deposit of 5% from each RA bill.	Agreed. Only ten percent (10%) of the completed value of work shall be retained as PBG during Defect Liability Period. Modified clause given in the Corrigendum issued with this compilation of replies to this PBQs. Please refer to the Corrigendum No:- SMPK/KDS/CIV/T/2829/639 dated 11/06/2024.	
3	The Defect Liability Period (DLP) is mentioned 10 yrs. Plus tenure of contract, i.e. 11 yrs. It is not possible to get any Bank Guarantee (BG) from any bank for such a long tenure. We request you to keep the DLP to maximum of 3 yrs. With a provision of release of 50% of the BG after completion of half of the DLP period i.e. 1.5 yrs. And balance on completion of the DLP.	Tender terms prevail	
4	It is seen that you have not kept any provision of cost for maintenance of road during DLP. Since, there is a lot of movement of heavy vehicles in these roads, there is possibility that the road may be damaged due to increased traffic load or other construction activities by other departments during DLP which cannot be attributed to the Contractor. Thus, we request you to provide for maintenance cost during DLP.	Tender clause prevails.	
5	It is seen that the estimates are based on PWD Schedule of rates of Govt. of West Bengal 2017. It is impossible to execute the works at rates which are old and it will be very difficult to provide a fair rate for the tender bid due to this huge gap between the current market rates vis-a-vis rates of 2017.	Estimated cost remains unaltered.	
6	We pray that since huge amount will already be available with Employer in form of PS, we shall be allowed to submit monthly bills to aid the cash flow position in the project. You are requested to please clarify the payment terms for the above project.	Payment would be released on submission of Invoices on the basis of measured works and on satisfaction of the quality of the same as per tender. Tender terms prevail.	

# NIT No SMPK/KDS/CIV /T/2829/11 DT. 08.03.2024

7	We want to confirm that payment made to	Tender terms prevail.
	us will be bill value plus 18% plus GST	
	altogether at the same time. The GST	
	amount shall be paid to us along with the bill	
	value after which we shall deposit the same	
	and reconcile with the GSTR. It is bad in law	
	and not a standard practice to hold the GST	
	amount payable to us and expect us to first	
	deposit the amount and seek reimbursement	
	from you. GST can only be deposited after	
	the same has been received from the	
	Employer. GST cannot be deposited on	
	anticipation of receipt of the same from the	
	Employer as huge amount is involved in this	
	and this shall severely affect the cash flow	
	position of the project. Please clarify the	
	same.	
8	Kindly clarify that BG from Private/Schedule	BG from Scheduled Bank will be accepted in addition
	bank also shall be allowed.	to BG from Nationalised Banks.
9	We request to provide for interest free	Tender terms prevails.
	mobilization advance of 10% against the	
	above project.	
10	Please provide all design, drawings, traffic	Proposed road sections, CRRI report /
	load calculations etc. for the above project	recommendation for upgradation of Port roads.
	to enable us to understand the scope and	Tenderer is also advised to check the sites to
	quantum of work and quote the most	assess the condition before submission of the bid.
	economical rates for the same.	
11	Filling fine sand is silver sand or Zone-IV red	Fine brown sand as per relevant specification.
	sand?	
12	Paver Block size or coverage.	120 mm thick M-55 grade. Size as specified by
		manufacturer complying with the requirements of
10		IS 15658-2006 or latest revision
13	Which type of MS structural work need to	As road side protective barrier beside drain , foot
	execute?	path etc.
14	DLP should be reduced in 3 yrs. and	Tender terms prevail.
4 -	Specification need to provide up to the mark.	Tandantanan ana il
15	Paid maintenance should be provided during	lender terms prevail
10	DLr DC should be released starswitz	Diagon refer to really against CL No.2
1 10		Fiedse relefito reply against SI. NO 3.

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From: "Binod Kumar" <binod.crri@nic.in> To: "ASHOK JAIN" <ce@kolkataporttrust.gov.in> Sent: Wednesday, October 28, 2020 10:36:12 AM Subject: Re: Consultation of CRRI for Change of Scheme towards improvement /strengthening of road in and around Dock area at Kolkata Dock System

Dear Sir,

The following is recommended for constructing the Interconnected Concrete Block Pavement (ICBP) for 55 and 80 msa traffic on existing bituminous pavements:

1. Dry Lean Concrete (DLC) layer having compressive strength of 10 MPa at 7 days, 120 mm thick, over existing bituminous pavement to fill the pot holes in the existing pavement and also to act as a base layer under ICBP.

2. Coarse sand bedding of 30 mm over DLC layer.

3. Paver blocks of M55 Grade, 120 mm thick, dentated or dumble-shaped to be provided over sand bedding.

4. Fine sand to be filled into joints of ICBP

For construction methodology and more information IRC:SP:63 and IS15658-2006 may be referred.

Regards,

Binod Kumar Sr. Pr. Scientist, RP Division CSIR-CRRI, New Delhi

# 1. INTRODUCTION

Kolkata Port Trust (KoPT) has a road network of 33 main roads in the vicinity of Dock covering a total length of 35 km. This work of giving recommendations for the improvement and strengthening of road network comprising of 26 roads in and around dock area of KoPT was assigned to the CSIR-Central road Research Institute, New Delhi by KPT vide its letter No. Civ/163/1047, dated 19<sup>th</sup> April, 2018. Field investigations including traffic survey, axle load survey, pits, Benkel Beam Deflection tests and visual distress surveys were conducted and soil samples were collected for laboratory testing. Based upon the collected field data and laboratory tests, recommendations were prepared for the improvement and strengthening of road network. Improvement with either bituminous layers or cement concrete layers has been suggested. This report contains the data collected from the field, laboratory test results and recommendations for the different roads of the network.

# 2. SCOPE OF THE PROJECT

The scope of the project work included the following:

- Assessment of the present condition of the existing road network.
- Traffic survey at 5-6 locations, axle load survey at one or two selected locations, testing of soil and other material collected from the site of existing roads.
- Recommendations for the improvement/strengthening of existing roads with cement concrete (rigid) pavement and bituminous (flexible) pavement.

# 3. FIELD INVESTIGATIONS OF PROJECT ROADS

In order to assess the structural condition of existing pavement layers and recommend the needed maintenance treatments the following activities were performed at the site by CSIR-CRRI team from 02.10.2018 to 06.10.2018:

- Assessment of pavement surface condition of all the project roads by visual inspection to find out the extent and severity of various distress types developed.
- Benkelman Beam Deflection measurements, as per IRC: 81-1997 on selected roads depending upon the road conditions
- Classified traffic volume survey at five locations on selected roads, round the clock
- Test pit observations
- Axle load survey at one location

The Methodology adopted for carrying out the above tasks/activities in the field and the data/results obtained there from are presented in the following sub-sections:

# 3.1 Assessment of Pavement Surface Condition

Pavement surface condition of the project roads was closely examined road by road and various distresses were observed on the project roads which typically include loss of materials, ravelling, cracking, pot holes, edge breaks and significant deformations/settlements/depressions etc. Keeping in view, the pavement surface condition, all the project roads are characterised into three categories i.e. good, fair and poor condition. Photos 1 to 7 shows the typical pavement condition observed on project roads.





Photo 1. Existing Condition of Road No. 33

Photo 2. Base Failure of Road No. 21



Photo 3. Rigid Pavement at Road No. 5



Photo 4. Newly Laid BC at Road No. 13





Photo 5. Water Logging at Road No. 12 Extension

Photo 6. Paver Block and MA at Road No. 1



Photo 7. Widening in Progress at Road No. 10/11

# 3.2 Test Pit Observations

Based on visual assessment of pavement surface conditions /surface defects, the locations of test pits were decided in consultation with Kolkata Port Trust officials. A total of three test pits, each measuring around 0.5 m x 0.5 m in size, representing the entire surface conditions of project roads, were dug up to the sub grade level. This has been used to study the correlation between the pavement deflection and pavement surface condition if any. The relationship is also being used to design and estimate the overlay thickness on the existing pavement. At each test pit, the following information has been recorded.

- > Test pit reference (Identification number, location);
- > Pavement composition (material type and thickness); and,
- Sub grade type (soil classification).

The sub-grade soils have been collected from each test pit location and were sent to the CSIR- CRRI laboratory for testing for various properties of soils. Photos 8, 9 and 10 present typical view of test pits dug on different road sections and Table 1 shows the details of test pits dug along the road sections.



Photo 8. Test Pit at Road Number 21

Photo 9. Crust Measurement at Road No. 33



Photo 10. Test Pit at Road No. 10/11

Test Pit	Road Section	Location	Pavement	Remarks
No.			Thickness	
1	Subhas Nagar road from CGR road to Dhobi Tala connector road No. 21	Near Port Trust Quarters	Granualar layer 450 cm	No bituminous layer is present
2	New road connecting Taratola road to Dhobitola /Sonarpur road (Road No. 33)	Near Castrol Company	Granualar layer 500 cm	No bituminous layer is present
3	Old and New Taratola Road (Road No. 11)	Near Widening Portion	Bituminous layer- 250mm Granular layer- 250 mm	

Table 1. Details of Test Pits and Total Pavement Thickness on Project Roads

# 3.3 Benkelman Beam Deflection (BBD) Measurements

Pavement evaluation involves a thorough study of various factors such as subgrade support, pavement composition and its thickness, traffic loading and environmental conditions. The primary objective of pavement condition evaluation is to assess as to whether and to what extent the pavement fulfils the intended requirements so that the maintenance and strengthening jobs could be planned in time. A well compacted pavement section deforms elastically under each wheel load application such that when the load moves away, there is an elastic recovery or rebound deflection of the deformed pavement surface. This is the basic principle of deflection method for overlay design of flexible pavement

The maximum deflection under a design wheel load depends on several factors such as sub-grade soil properties, moisture in the subgrade, pavement thickness and its composition, temperature of the pavement, loading particulars, etc. Therefore the amount of pavement deflection under a design wheel load or its rebound deflection on removal of this load is a measure of the structural stability of the pavement system under the prevailing condition of the test. Larger rebound deflection indicates weaker pavement structure, which may require earlier strengthening or higher overlay thickness. It is desirable to carry out the deflection studies soon after the monsoon when the pavement system may be at the weakest condition due to maximum sub-grade moisture content.

#### 3.3.1 Benkelman Beam

Benkelman Beam is a device, which can be conveniently used to measure the rebound deflection of a pavement due to a dual wheel load assembly or the design wheel load. The equipment consists of a slender beam of length 3.66m, which is pivoted to a datum frame at a distance 2.44m from the probe end. The datum frame rests on a pair of firm leveling legs and a rear leg with adjustable height. The probe end of the beam is inserted between the dual rear wheels of the truck and placed on the pavement surface at the centre of the loaded area of the dual wheel load assembly. A dial gauge is fixed on the datum frame with its spindle in contact with the other end of the beam in such a way that the distance between the probe end and the fulcrum of the beam is twice the distance between the fulcrum and the dial gauge spindle. Thus the rebound deflection reading measured at the dial gauge is to be multiplied by two to get the actual movement of the probe end due to the rebound deflection of the pavement surface when the dual wheel load assembly of 8170 kg is used for the deflection study. The design wheel load is a dual wheel load assembly of gross weight 4085kg with tire pressure of 5.6 kg/cm2.

## 3.3.2 Correction

When the pavement consists of relatively thick bituminous layers like the bituminous macadam or bituminous concrete in the base/binder/surface course, variations in temperature of pavement surface course cause variation in pavement deflection under the standard load. The IRC:81 has suggested a standard pavement temperature of 35° C and a correction factor of 0.01 mm per °C to be applied for the variation from this standard pavement temperature. The correction will be negative when the pavement temperature is above 35° C and positive when it is lower.

The seasonal variations cause variation in sub-grade moisture. It is always not possible to conduct deflection studies during monsoon season when subgrade moisture content is the highest. IRC:81 1997 has suggested correction factors for clayey soils and sandy subgrade soils for various PI values. These may be adopted if the deflection measurements are made during dry seasons. The deflection under the worst sub-grade moisture may therefore be estimated by multiplying the rebound deflection value with appropriate seasonal correction factor.

Photos 11 and 12 shows the Benkelman Beam test in Progress. The test was conducted on representative roads of all project roads and same was categorised based on deflection data and road surface condition.
The analysis of collected data shows that characteristic deflection varies from 0.7 mm to 1.5 mm. Keeping in view the pavement surface condition, all the project roads categorized in the three categories viz. good, fair and poor. Benkelman Beam Deflection study was conducted on five selected roads covering all categories of project roads, in order to determine the structural adequacy of project roads.



Photo 11. BBD Measurements in Progress

Photo 12. BBD Measurements in Progress

## 3.4 Traffic Volume Count Survey

Classified traffic volume surveys were conducted manually for 24 hours round the clock, at five locations by employing skilled enumerators, covering all types of commercial vehicles only viz; light commercial vehicles, light passenger vehicles, 2-axle trucks, multi-axle trucks and buses.

The traffic volume survey was conducted on the roads such as Road number 1, Road number 4, Road number 10/11, Road number 23 and Road number 31. The traffic volume data, so collected has been complied on 24 hours basis, separately for each of the two directions of project road at all the five locations. The traffic volume data separately for each type of commercial vehicles and total number of Commercial Vehicles Per day (CVPD) for the both the traffic directions at all five locations were recorded. Table 2 present the summary of data on total number of Commercial Vehicles Per day (CVPD) found to be plying on project roads and Figures 1 to 5 show the composition of the traffic on the project roads. Photo 13 shows typical view of traffic volume survey at Hide road.

Type of Traffic	LCVs	LPVs	Bus	2 Axle Truck	3 Axle	4 Axle	5 Axle	CVPD
Road No.1 Hide Road, Taratala road to Junction	907	52	159	657	775	597	358	3505
Road No.1 Hide Road, Junction to Taratala road	866	49	136	487	561	402	184	2685
Road No.1 Total (Both Directions)	1773	101	295	1144	1336	999	542	6190
Road No. 4, Taratala to Hide Road	2	0	0	21	143	150	102	418
Road No. 4, Hide Road to Taratala	2	0	0	6	107	113	62	290
Road No. 4 Total (Both Directions)	4	0	0	27	250	263	164	708
Road No. 10/11, Diamond Harbor to CGR	869	46	437	413	557	299	245	2866
Road No. 10/11, CGR to Diamond Harbor	1110	85	619	381	449	271	168	3083
Road No. 10/11 Total (Both Directions)	1979	131	1056	794	1006	570	413	5949
Road No.23, Century CFS to Hide Road	70	0	0	519	669	846	989	3093
Road No. 23, Hide Road to Century CFS	26	0	0	535	829	942	1152	3484
Road No. 23 Total (Both Directions)	96	0	0	1054	1498	1788	2141	6577
Road No. 31 Hoboken Road, Hide road to Coal dock Road	557	106	590	520	468	204	250	2695
Road No. 31 Hoboken Road, Coal dock Road to Hide road	978	134	744	590	448	202	164	3260
Road No. 31 Total (Both Directions)	1535	240	1334	1110	916	406	414	5955

Tables 2. Summary of Data on Total Number of Commercial Vehicles (Direction wise) on

**Project Roads** 

Note: Traffic Volume Survey was conducted from 03.10.2018 (10.00 am) to 04.10.2018 (10.00 am)



Fig. 1. Traffic Composition for Road No. 1



Fig. 2. Traffic Composition for Road No. 4



Fig. 3. Traffic Composition for Road No. 10/11



Fig. 4. Traffic Composition for Road No. 23



Fig. 5. Traffic Composition for Road No. 31



Photo 13. Traffic Survey in Progress on Road No.1

## 3.5 Axle Load Survey

The number of commercial Vehicles and the load carried by them, over a pavement, is the key factor which determines the structural and rehabilitation design of pavements and its subsequent performance over the design life. The axle load survey was undertaken on project road at gate number 3 and gate number 8 for both loaded and unloaded trucks respectively.

The axle load survey was undertaken for determination of Vehicle Damage Factor (VDF) for 12 hours (during day hours only), since it was learnt that the commercial vehicles, mainly the trucks, light commercial vehicles, light passenger vehicles and buses on project road in the day hours only, due to poor condition of the roads. Photo 14 shows arrangements for axle load survey at gate number 3, where empty trucks are exiting from the dock and Photo 15 show axle load survey in progress at gate number 8 where loaded trucks are entering into the dock yard. The data on wheel loads were collected by using static wheel weigh pads for different types of commercial vehicles, as per the vehicle configuration code, given in Figure 6. The wheel loads of commercial vehicles, which included primarily the Light Commercial Vehicle (LCVs), Light Passenger Vehicles (LPVs), Buses, Two – Axle trucks and Multi – Axle trucks were noted down using

the static weigh pads. The vehicles weighed were selected and stopped on random sampling basis for weighing purpose on representative basis, covering the loaded, partially loaded and unloaded vehicles. The wheel loads so obtained were then multiplied by a factor of two (2) in order to obtain the axle loads. The axle load data is finally converted into Equivalent Standard Axles (ESALs) carried by each axle of the vehicle.

The damaging effect of axles for different vehicles, in comparison with the standard axles have been worked out by applying "Fourth Power Law", using the following equations:

- (i) Damaging Factor for Front Axle = [ Front Axle Load (kg) ]<sup>4</sup>
- 6600 (ii) Damaging Factor for Rear Axle = [<u>Rear Axle Load (kg</u>)]<sup>4</sup>
- (iii) Damaging Factor for Tandem Axle = [<u>Tandem Axle Load (kg</u>)]<sup>4</sup> 15100



Photo 14. Axle Load Survey at Gate NO. 3

Photo 15. Axle Load Survey at Gate No. 8

Summation of damaging effects of all the vehicles weighed during the axle load survey gave the total damaging effects for all the vehicles weighed. The vehicle damage factor (VDF) was computed as follows:

Number of vehicles weighed

VDF values were also computed for individual vehicle class (as shown in Fig. 6). The results on calculated VDFs for light commercial & Passenger Vehicles, Buses, 2,3,4,5+ Axle trucks are given in Table 3, which

have been used for computation of projected traffic loading in terms of cumulative number of standard axle loads during the design life of flexible overlay.



Figure 6. Figure Showing Individual Vehicle Class

Type of the vehicle	VDF
LCV + LPV	0.8
Bus	1.0
2 Axle Truck	3.5
3 Axle	7.012
4 Axle	12.789
5+ Axle	5.55

### Table 3. Vehicle Damage Factors (VDFs) for Project Roads

## 4. ANALYSIS AND DISCUSSION OF DATA/RESULTS

Variety of data/results obtained through the conduct of various field surveys/activities, as given in previous sections, were then processed/analyzed/computed to get the final output, which has been used for determining the strengthening/rehabilitation/reconstruction requirements of project roads. The data collected and analyzed for the evaluation of project roads as well as for reconstruction have been discussed in the following sub-sections

### 4.1 Pavement Surface Distress

The distress on the existing pavement surface was assessed through visual condition survey. The extent of various types of distress and their quantum for different sections of project road may be summarized as under:

Based upon the distress observed pavement surface are categorized in three categories viz. good, fair and poor. Keeping in view the pavement surface condition, all the project roads categorized in the three categories and Benkelman Beam Deflection study was conducted on five selected roads covering all categories of project roads, in order to determine the structural adequacy of project roads. The condition of the roads based on the visual survey for all the project roads is given in Table 4.

Road No.	Name of the Road	Existing Surfacing	Existing Condition
1	CGR Road, Diversion Road from Gate No. 5 NSD to Gate No. 9 NSD	Bituminous	Poor
2	Dhobitala Road from CGR Road Crossing to End Container Park	Granular	Poor
3	Harimohan Ghosh Road	Bituminous	Fair
4	Road from CGR Road Crossing to Paharpur Cooling Tower connecting Hydraulic Model	Granular	Poor
5	Brace Bridge Road from Gate No 3, GRG to Main Gate of Libyan Warehouse	Bituminous, Cement Concrete & Paver Block	Good
6	Road from Gate No. 3 NSD to Main Gate of Libyan Warehouse	Paver Block	Good
8	Connecting Road between Taratala Road to Sick line (Paharpur) Road	Granular	Poor
9	Old Garagacha Road	Bituminous	Fair
10	New Taratala Road	Bituminous	Fair
11	Old Taratala Road	Bituminous	Fair
12	Transport Depot Road and Transport Depot Road Bypass upto level crossing	Bituminous	Fair

## Table 4. Condition of different Project Roads as per Visual Survey

Road No.	Name of the Road	Existing Surfacing	Existing Condition
		Granular	Poor
13	Helen Killer Sarani Road	Bituminous (recently done)	Good
14	Remount Road	Bituminous	Poor
15	Durgapur yard Road	Granular	Poor
16	Garagcha Road	Granular	Poor
17	Mint Place Road	Bituminous	Fair
18	Low Level Bypass Road on both side of Brace Bridge	Granular	Poor
20	Cross Road connecting CGR Road and Brooklyn Depot (Singherhati Road)	Bituminous	Fair
21	Subhas Nagar Road from CGR Road to Dhobi Tala Connector	Bituminous	Fair
	Road	Granular	Poor
23	Road from Hide Road leading towards JJP Area	Granular	Poor
25	Road leading to Centenary Hospital	Bituminous	Good
26	Hide Road & Hide Road Extension	Bituminous (Recently done)	Fair

Road No.	Name of the Road	Existing Surfacing	Existing Condition
		Approaches to Level Crossing	Poor
30	Dock East Boundary Road	Bituminous	Fair
31	Haboken Road	Granular	Poor
32	Dock West Boundary Road	Bituminous	Fair
33	New Road connecting Taratola Road to Dhobitola /Sonarpur Road	Bituminous Base Failure	Poor

[Roads No. 7, 19, 27, 28 and 29 are not covered under the scope of CSIR-CRRI work]

## 4.2 Evaluation of Soil Samples Collected from Test Pits

The laboratory evaluation included testing for engineering characteristics of in-situ soil material retrieved through number of test pits dug along the different roads has been done in CSIR-CRRI laboratory. Laboratory evaluation of the soil collected from field aimed at evaluating them for their compliance in pavement design with the required properties for a good performance. The various samples of soil were subjected to detailed laboratory investigations for the following properties.

Property	Method of Test
Grain Size Analysis	IS: 2720 (Part-IV) :1985
Atterberg's Limits	IS: 2720(Part-V) : 1985
Compaction Characteristics	IS: 2720 (Part-VIII) :1983
Moisture Content	IS: 2720 (Part-II) :1973
California Bearing Ration (CBR)	IS: 2720 (Part-XVI) : 1987

The samples collected at different locations were brought to CSIR-CRRI and detailed laboratory test were carried out to determine their gradation, Atterberg's limit, Maximum Dry Density and CBR etc. The laboratory test results of the soil samples collected from the different test pit locations are given in Table 5. The data reveals that the bed on which pavement has been laid contains gravel and sand size particles along with the non-plastic fine grained soils. The average density of soil samples were found to be 1.91 to 2.12 gm/cc and CBR values varying from 4.0 to 6.8 percent.

	Road	Location of the Pit	Percent Passing through IS Sieve					Gravel	Sand							Turne	
Pit No.			20 mm	10 mm	4.75 mm	2.36 mm	0.425 mm	0.075 mm	Gravel contt. (%)	Sand contt. (%)	LL (%)	PL (%)	PI (%)	MDD (gm/cc)	OMC (%)	CBR (%)	of Soil
1	Road No.21 Subhas Nagar Road from CGR Road to Dhobi Tala Connector Road	Near Port Trust Quarters	100	87	85	82	79	72	15	13	30	21	9	1.92	11.5	4.5	CL
2	Road No. 33 New Road connecting Taratola Road to Dhobitola /Sonarpur Road	Near Castrol Company	100	99	95	91	76	57	5	38		_	NP	2.12	10.50	6.8	ML
3	Road No. 10/11 New and Old Taratola Road	Near Widening side	100	97	94	92	90	89	6	5	29	19	10	1.91	11.80	4.0	CL
	LL- Liquid Limit PL-Plastic Limit PI-Plasticity Index MDD-Maximum Dry Density OMC- Optimum Moisture Content CBR- California Bearing Ratio NP-Non Plastic ML- Silty Clay CL-Clayey																

## Table 5: Laboratory Test Results of Soil Samples Collected from Different Test Pits

## 4.3 Computation of Projected Traffic Loading

The design traffic is considered in terms of cumulative numbers of standard axles (CSA) to be carried during the design life of road. This is computed using the following equation:

$$N = \{365^*[(1+r)^n - 1]^* A^* D^* F\}/r$$

Where

- N = the cumulative number of standard axles to be catered for in the design in terms of MSA (Million Standard Axle)
- A = Initial Traffic, in the year of completion of construction, in terms of the number of commercial vehicles per day
- r = Annual growth rate of commercial vehicles
- D = Lane Distribution Factor
- n = Design life in year
- F = Vehicle damage factor

The implementation period including necessary tendering process and construction period has been assumed to be one year for proposed roads and all the roads will be opened to traffic in 2019. Therefore the traffic in the year of completion is estimated using the formula given in clause 4.6.1 of IRC: 37-2012.

A = 
$$P x (1+r)^{x}$$

P = Number of commercial vehicles as per last count

x = Number of years between the last count and the year of completion of construction.

The various parameters considered for design purposes are given as under:

- Traffic growth rate = 5%
- Year of construction = 1 Year
- Lane distribution factor for 2 lane single carriageway = 0.5
- Design life = 10 year

Seasonal variation factor for converting ADT into AADT is considered as 4% for safe side as the data for calculation of seasonal variation factor is not available. Initial traffic adopted in below calculations are AADT values i.e 4% more than ADT values that were obtained from the traffic volume count as already given in Table 2. The computation of projected number of standard axles to be catered during the design

life of pavements by considering above said parameters are shown in Tables 6 to 10 for selected five roads on which traffic volume surveys were conducted.

			CU	MULATIVE	E MSA CALCU	LATION of Road	No.1 for 10 yr			
i)	2 Lane With	Paved Sho	ulder							
ii)	Initial Traffi	c in Both D	irections							
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Ax	Total			
	1949	307	1190	1389	1039	564	6438	Base Year	2018	
	Traffic Grov	vth Conside	red is 5.00%	)						
	$A = P^{*}(1+r)$	x		Initial Traffi	c in both Direct	ions in the Year of O	Completion of Cons	truction		
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Ax	Total			
	2046	322	1249	1459	1091	592	6759	CV/Day	Completion 7	Year 2019
iii)	Design Life							10	Years	
iv)	Traffic Grov	vth Rate						5.00%		
v)	Vehicle Dan	nage Factor	(Found out	from Axle Lo	ad Survey on E	xisting Road)				
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Axle	2			
	0.8	1	3.5	7.012	12.789	5.55				
vi)	Distribution	Factor						50.0%		
vii)	Cumulative	Number of	Standard A	des to be cari	ried During Des	ign life of 10 Years				
						0				
	N =	30	55 x [(1+r)]	" - 1]	- x A x D x F					
			r							
	LCV +LPV =	365	x[((1+0.05)	^10)-1]	x 2046 x 0.8	x 0.5		=	3.757 msa	
			0.05							
	DUG	365	x [ ((1+0.05)	^10)-1]		_			0 = 20	
	BUS =		0.05		x 322 x 1 x 0	.5		=	0.739 msa	
	2 Axle =	365	x [ ((1+0.05)	^10)-1]	x 1249 x 3.5	x 0.5		=	10.035 msa	
			0.05							
	3 Axle =	365	x [ ((1+0.05)	^10)-1]	x 1459 x 7.0	12 x 0.5		=	23.484 msa	
			0.05							
	4 axle	365	x [ ((1+0.05)	^10)-1]	x 1091 x 12.	789 x 0.5		=	32.028 msa	
			0.05							
	363643	0.65	F ((1 0 0F)	410) 11						
	Multi Axle	365	x [ ((1+0.05)	/10)-1]	- x 592 x 5.55	x 0.5		=	7.542 msa	
	5++ Axle		0.05							
								Total	77.58 msa	
1										

## Table 6. Cumulative MSA for Road No. 1 for 10 years

			CUN	/III.ATIVE	MSA CALCU	LATION of Road	no 23 for 10 yr			
i)	2 Lane With	Paved Sho	ulder				10120 101 10 91			
-/ ii)	Initial Traffi	c in both Di	rections							
<i></i>	LCV +LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total	1		
	100	0	1096	1558	1860	2227	6840	Base Year	2018	
	Traffic Grov	wth Conside	red is 5.00%		_					
	A = P * (1+r)	) <sup>x</sup>		Initial Traffic	in both Directio	ns in the Year of Com	pletion of Construct	tion		
	LCV +LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total	1		
	105	0	1151	1636	1952	2338	7182	CV/Day	Completion Y	ear 2019
iii)	Design Life							10	Years	
	U				_					
iv)	Traffic Grov	wth Rate						5.00%		
v)	Vehicle Dan	nage Factor	(Found out fi	om Axle Loa	d Survey on Exis	ting Road)				
	LCV +LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Axle				
	0.8	1	3.5	7.012	12.789	5.55				
;)	Distribustion	Ersten						E 0. 00/		
V1)	Competence	Factor Number of	Ctom Jourd April		d Dunin e Danion	life of 10 Verse		50.0%		
VШ)	Cumulative	Number of	Standard Axi	es to be carrie	a During Design	life of 10 Years				
	N	3	65 x [(1+r) <sup>n</sup>	- 1]						
	IN = -		r		-XAXDXF					
		365	x [((1+0.05)/	<u>\10)-1]</u>						
	LCV =		0.05	, 1	— x 105 x 0.8 x	0.5		=	0.193 msa	
		0.65	F ((1 0 05)	A 1 O \ 1 ]	_					
	BUS =	365	x [ ((1+0.05)	~10)-1]	x 0 x 1 x 0.5			=	0.000 msa	
			0.05							
	2 Avla -	365	x [ ((1+0.05)	^10)-1]	v 1151 v 25	x 0 5		_	0.247 mm	
	2 AXIC =		0.05		X1151 X 5.5	x 0.J		_	9.247 IIISd	
	2 Avla	365	x [ ((1+0.05)	^10)-1]	w 1626 w 7.01	2 - 0 5			26222 mm	
	5 Axie =		0.05		x 1030 x 7.01	12 X U.J		=	20.555 IIIsa	
	4 axle	365	x [ ((1+0.05)	^10)-1]	x 1952 x 12 2	789 x 0 5		_	57 304 msa	
	T UARC .		0.05		x 1752 x 12.	07 x 0.5			57.501 1134	
	Multi Axle	365	x [ ((1+0.05)	^10)-1]	- x 2338 x 5.55	5 x 0.5		=	29.786 msa	
	5++ Axle		0.05		12000 10100				270.00 1104	
								Total	122.86 msa	

# Table 7. Cumulative MSA for Road No. 23 for 10 years

			CUM	IULATIVE	MSA CALCUI	LATION of Road No	o. 31 for 10 vi			
i)	2 Lane With	Paved Sho	ulder							
., ii)	Initial Traffic	c in both Di	rections							
	LCV+LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total			
	1846	1387	1154	953	422	431	6193	Base Year	2018	
	Traffic Grow	vth Conside	red is 5.00%							
	A = P * (1+r)	x		Initial Traffic	in both Directio	ns in the Year of Comp	letion of Constru	ction		
	LCV+LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total			
	1938	1457	1212	1000	443	452	6502	CV/Day	Completion Y	ear 2019
iii)	Design Life							10	Years	
v)	Traffic Grow	vth Rate						5.00%		
vi)	Vehicle Dam	age Factor	(Found out fr	om Axle Loa	d Survey on Exis	ting Road)				
	LCV+LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Axle				
	0.8	1	3.5	7.012	12.789	5.55				
vii)	Distribution	Factor						50.0%		
viii)	Cumulative	Number of	Standard Axle	es to be carrie	d During Design	life of 10 Years				
		0	265 [(1)]	11						
	N = -	5	05 X [(1+1)]	- 1]	_x A x D x F	1				
			r							
		365 x [((1+0.05)^10)-1]								
	LCV =	50.	0.05	10)-1]	x 1938 x 0.8	x 0.5	=	3.559 msa		
					_					
	BUS =	365	5 x [ ((1+0.05)	^10)-1]	x 1457 x 1 x	0.5		=	3.344 msa	
			0.05							
	2 Arla -	365	5 x [ ((1+0.05)	^10)-1]	v 1010 v 2 5	x 0 5			0.737 mm	
	2  Axie = -		0.05		x 1212 x 3.5	x 0.5		-	9.7.57 IIISd	
	3 Avle -	365	5 x [ ((1+0.05)/	^10)-1]	x 1000 x 7 0	12 - 0 5		_	16.096 mm	
	5 / 1410 -		0.05		x 1000 x 7.0	12 x 0.5			10.090 1113a	
	4 axle	365	$5 \times [((1+0.05))]{0.05}$	^10)-1]	x 443 x 12.78	39 x 0.5		=	13.005 msa	
			0.05							
	Multi Axle	365	5 x [ ((1+0.05))	^10)-1]						
	5++ Axle		0.05		— x 452 x 5.55	x 0.5		=	5.758 msa	
								Total	51.50 m∞	

# Table 8. Cumulative MSA for Road No. 31 for 10 years

			CUMU	LATIVE M	SA CALCULAT	FION of Road NO.	10/11 for 10	vr		
i)	2 Lane With Pa	aved Should	er							
í)	Initial Traffic in	n Each Direc	tions							
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total			
	2194	1098	826	1046	593	430	6187	Base Year	2018	
	Traffic Growth	Considered	is 5.00%							
	$A = P * (1+r)^x$			Initial Traffic	in both Directio	ns in the Year of Comp	letion of Constr	uction		
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total			
	2304	1153	867	1099	622	451	6496	CV/Day	Completion Y	ear 2019
iii)	Design Life							10	Years	
v)	Traffic Growth	Rate						5.00%		
vi)	Vehicle Damag	e Factor (Fo	ound out from	n Axle Load S	urvey on Existin	g Road)				
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Axle				
	0.8	1	3.5	7.012	12.789	5.55				
vii)	Distribution Fa	ctor						50.0%		
viii)	Cumulative Nu	umber of Sta	ndard Axles	to be carried l	During Design life	e of 10 Years		50.070		
•)	Cumulative Number of Standard Axies									
	N =	3	65 x [(1+r)	<sup>n</sup> - 1]	- x A x D x F					
			r							
		365	x [((1+0.05)	)^10)-1]						
	LCV =		0.05	, -	x 2304 x 0.8	x 0.5		=	4.231 msa	
	BUIC _	365	x [ ((1+0.05)	)^10)-1]	v 1152 v 1 v 0 5				2647 mm	
	D03 -		0.05		x1155 x1 x	0.5		_	2.047 1115a	
		365	x [ ((1+0.05)	)^10)-1]						
	2 Axle =		0.05	,, -]	— x 867 x 3.5 x	0.5		=	6.966 msa	
		365	x [ ((1+0.05	)^10)-1]						
	3  Axle =		0.05		— x 1099 x 7.0	12 x 0.5		=	17.689 msa	
	4 axle	365	x [ ((1+0.05	)^10)-1]	x 622 x 12.78	89 x 0.5		=	18.260 msa	
			0.05							
	Multi Axle	365	x [ ((1+0.05)	)^10)-1]						
	5++ Axle	200	0.05		x 451 x 5.55	x 0.5		=	5.746 msa	
	-									
								Total	55.54 msa	

# Table 9. Cumulative MSA for Roads No. 10/11 for 10 years

					MANGALO		N. 4.6 10			
	D. L	D. 101.		MULAIIVE	M SA CALCU	LATION OF KOAd	No. 4 for fuyr			
1) 	2 Lane With	1 Paved Sno	ulder							
11)		ic in doth Di	rections	0.4.1	4 1		m . 1			
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total		2010	
	4	0	28	260	274	171	736	Base Year	2018	
	Traffic Grov	wth Conside	red 1s 5.00%							
	A = P * (1+r)	.) <sup>x</sup>		Initial Traffic	in both Directio	ns in the Year of Com	pletion of Construct	tion		
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ A	Total			
	4	0	29	273	287	179	772	CV/Day	Completion Y	ear 2019
iii)	Design Life							10	Years	
iv)	Traffic Grov	wth Rate						5.00%		
v)	Vehicle Dan	nage Factor	(Found out i	from Axle Loa	d Survey on Exi	sting Road)				
	LCV + LPV	Bus	2 Axle	3 Axle	4 axle	Multi Axle 5++ Axle				
	0.8	1	3.5	7.012	12.789	5.55				
vi)	Distribution	Factor						50.0%		
vii)	Cumulative	Number of	Standard Ax	les to be carrie	d During Design	life of 10 Years		501070		
• 11)	Guillumuive	i tumber or								
	N -	3	65 x [(1+r)	<sup>n</sup> - 1]	vAvDvF					
	11 -	r r								
	1.017	$365 \text{ x} [((1+0.05)^{10})-1]$		4 0 0 0	_			0.007		
	LCV =		0.05		- x 4 x 0.8 x 0.1	0		=	0.007 msa	
		0.65	F //1 0 05	(410) 11						
	BUS =	365	x [ ((1+0.05	/~10)-1]	x 0 x 1 x 0.5			=	0.000 msa	
			0.05							
	0.4.1	365	x[((1+0.05)	)^10)-1]	00 0 5 0	. –			0.000	
	2  Axle = -		0.05		- x 29 x 3.5 x 0	1.5		=	0.233 msa	
		365	x [ ((1+0.05)	)^10)-1]			1			
	3  Axle =		0.05		- x 273 x 7.012	2 x 0.5		=	4.394 msa	
	4 1	365	x [ ((1+0.05	)^10)-1]	007 10 7	0.05			0.405	
	4 axle		0.05	. , ]	x 28/ x 12./8	39 x 0.5		=	8.425 msa	
	Multi Axle	365	x [ ((1+0.05)	)^10)-1]	170 5 55	0.5			2.200	
	5++ Axle		0.05		x 1/9 x 5.55	x U.S		=	2.280 msa	
								Total	15.34 msa	
			1		1			1		

# Table 10. Cumulative MSA for Road No. 4 for 10 years

The summary of cumulative standard axles (MSA), as calculated in Tables 6 to 107 for selected five road is given in Table 11 for ready reference.

Road No.	Calculated MSA for		
	Design Life of 10		
	Years		
1	77.58		
10/11	55.54		
31	51.50		
23	122.86		
4	15.34		

Table 11. Summary of Calculated MSA for Five Selected Project Roads

The data shown in Table 11 shows that MSA for design life of 10 years is varying from 15.34 to 122.86 MSA. However, the MSA on Road No. 23 worked out 122.86 MSA, which seems to be too high, keeping in view the traffic and axle load plying on roads in and around dock area of Kolkata Port Trust. Hence, an appropriate design traffic loading for design life of 10 years for calculation of strengthening and overlay requirements on project roads in and around dock area of Kolkata Port Trust, is given as under:

- High traffic volume roads: 80 MSA
- Medium traffic volume roads: 55 MSA
- Low traffic volume roads: 15 MSA

Further, for local streets/roads approaching to residential areas/roads along the market area, the projected traffic loading of 5 million standard axles has been adopted for the purpose of assessing the resurfacing/strengthening requirements.

During the site visit, discussions were held with Kolkata Port Trust officials to categorize project roads based upon their experience as high, medium and low traffic volume roads, so that appropriate design traffic may be assumed for arriving strengthening and overlay requirements of project roads. From the discussion, it is understood that the project roads may be categorized as high, medium and low traffic volume roads as given below in Table 12. Accordingly, the design traffic for 10 years design in terms of MSA is also given in Table 12, which has been considered to arrive strengthening/overlay requirements on existing flexible pavements.

Road No.	Name of the Road	Traffic Volume	Adopted Design Traffic (MSA) for Design Life of 10 Years
1	CGR Road Diversion Road from Gate No. 5 NSD to Gate No. 9 NSD	High	80
2	Dhobitala Road from CGR Road Crossing to End Container Park	High	80
3	Harimohan Ghosh Road	Medium	55
4	Road from CGR Road Crossing to Paharpur Cooling Tower connecting Hydraulic Model	High	80
5	Brace Bridge Road from Gate No 3, GRG to Main Gate of Libyan Warehouse	High	80
6	Road from Gate No. 3 NSD to Main Gate of Libyan Warehouse	High1	80
8	Connecting Road between Taratala Road to Sick line (Paharpur) Road	High	80
9	Old Garagacha Road	High	80
10	New Taratala Road	High	80
11	Old Taratala Road	High	80

 Table 12. Categorization of Project Roads based on Traffic Volume and Adopted Design Traffic (MSA)

Road No.	Name of the Road	Traffic Volume	Adopted Design Traffic (MSA) for Design Life of 10 Years
12	Transport Depot Road and Transport Depot Road Bypass upto level crossing	High	80
13	Helen Killer Sarani	Medium	55
14	Remount Road	Medium	55
15	Durgapur yard Road	Medium	55
16	Garagcha Road	High	80
17	Mint Place Road	Low	15
18	Low Level Bypass Road on both side of Brace Bridge	High	80
20	Cross Road connecting CGR Road and Brooklyn Depot (Singherhati Road)	Medium	55
21	Subhas Nagar Road from CGR Road to Dhobi Tala Connector Road	Medium	55
23	Road from Hide Road leading towards JJP Area	High	80
25	Road leading to Centenary Hospital	Medium	55

Road No.	Name of the Road	Traffic Volume	Adopted Design Traffic (MSA) for Design Life of 10 Years
26	Hide Road & Hide Road Extension	High	80
30	Dock East Boundary Road	High	80
31	Haboken Road	High	80
32	Dock West Boundary Road	Local Street	5
33	New Road connecting Taratola Road to Dhobitola /Sonarpur Road	High	80

[Roads No. 7, 19, 27, 28 and 29 are not covered under the scope of CSIR-CRRI work]

## 4.4 Computation of Characteristic Deflection

Benkelman Beam Deflection study was conducted on five selected roads covering all categories of project roads viz good, fair and poor, in order to determine the structural adequacy of project roads. The analysis of collected data shows that characteristic deflection varies from 0.70 mm to 1.50 mm. The characteristic deflection with existing road surface condition for five roads on which BBD study was conducted are given in Table 13. Depending upon the pavement surface condition and characteristic deflection values as observed from various roads the criterion given in Table 14 may be used to adopt the characteristic deflection value for categories of all project roads on which flexible overlay is suggested.

S.No	Name of the Port Road	Existing Surface	Characteristic
		Condition	Deflection (mm)
1	CGR Road Diversion Road from Gate	Poor	1.24
	No. 5 NSD to Gate No. 9 NSD		
10/11	Old/New Taratala Road	Fair	0.811
13	Helen Killer Sarani Road	Good	0.702
14	Remount Road	Poor	1.5
20	Cross Road connecting CGR Road	Fair	0.806
	and Brooklyn Depot (Singherhati		
	Road)		

 Table 13. Characteristic Deflection Value (IRC: 91-1997)

Table 14. Table Showing the Adopted Deflection Criteria depending upon the Road Surface
Condition

Road Surface Condition	Characteristic Deflection, mm		
Poor	> 1.20		
Fair	0.80 -1.20		
Good	< 0.80		

Kolkata Port Trust has given assignment to CSIR-CRRI to evaluate total 26 project roads in and around Dock area to provide flexible/concrete pavements. On investigation it was found that out of total 26 roads, only 17 roads were suitable for flexible overlay as per the details given in Table 15. Further, based on the criteria given in Table 14, the adopted value of characteristic deflection which has been considered for arriving strengthening/overlay requirements and also given in Table 15 with their existing pavement surface condition.

 Table 15. Details of Roads Suitable For Flexible Overlay with Characteristic Deflection and their

 Existing Surface Condition

Road No.	Road Name	Existing Surface	Characteristic
		Condition	Deflection (mm)
1	CGR Road, Diversion Road from	Poor	1.24
	Gate No. 5 NSD to Gate No. 9 NSD		
3	Harimohan Ghosh Road	Fair	1.00
5	Brace Bridge Road from Gate No 3,	Good	
	GRG to Main Gate of Libyan		
	Warehouse		
6	Road from Gate No. 3 NSD to Main	Good	
	Gate of Libyan Warehouse		
9	Old Garagacha Road	Fair	1.00
10	New Taratala Road	Fair	0.80

11	Old Taratala Road	Fair	0.80
12	Transport Depot Road and	Fair	1.00
	Transport Depot Road Bypass upto		
	level crossing		
13	Helen Killer Sarani Road	Good	0.70
14	Remount Road	Poor	1.50
17	Mint Place Road	Fair	1.00
20	Cross Road connecting CGR Road	Fair	0.80
	and Brooklyn Depot (Singherhati		
	Road)		
21	Subhas Nagar Road from CGR	Fair	0.80
	Road to Dhobi Tala Connector Road		
25	Road leading to Centenary Hospital	Good	
26	Hide Road & Hide Road Extension	Fair	1.00
30	Dock East Boundary Road	Fair	1.00
32	Dock West Boundary Road	Fair	1.00

## 4.5 Strengthening Requirements of Project Roads

The structural adequacy of the project roads have been worked out using the characteristic deflection (Table 15) and the estimated cumulative number of standard axles (Table 12). With these data available (i.e. characteristic deflection and the projected traffic loading), overlay thicknesses have been worked out in terms of bituminous macadam (BM) as per IRC:81-1997 (Figure 7) using appropriate interpolation techniques for the appropriate MSA curve. The overlay thickness derived in terms of Bituminous Macadam (BM) are then converted into Dense Bituminous Macadam (DBM) and Mastic Asphalt/Bituminous Concrete (BC) equivalent (1cm BM= 0.7 cm DBM/BC), as per the recommended practice given in IRC: 81-1997, since the existing bituminous surface of road section is mastic asphalt on all the roads, the condition of the roads were also varying from road to road. The strengthening requirements of the bituminous roads are as given in Table 16.



Fig. 7. Overlay Thickness Design Curves (IRC: 81-1997)

Road No.	Name of the Road	Existing Surfacing	Existing Condition	Estimated Traffic for 10 Yr Design Life (msa)	Characteristic Deflection (mm)	Recommended Treatment (mm)	Remarks
1	CGR Road Diversion Road from Gate No. 5 NSD to Gate No. 9 NSD	Bituminous	Poor	80	1.24	75 DBM + 40 MA/ SMA	On CC paver blocks, no treatment is needed
2	Dhobitala Road from CGR Road Crossing to End Container Park	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
3	Harimohan Ghosh Road	Bituminous	Fair	55	1.2	50 DBM + 40 MA/ SMA	Nil
4	Road from CGR Road Crossing to Paharpur Cooling Tower connecting Hydraulic Model	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
5	Brace Bridge Road from Gate No 3, GRG to Main Gate of Libyan Warehouse	Bituminous & Cement Concrete	Good	80		No treatment needed	40 MA/SMA after two years
6	Road from Gate No. 3 NSD to Main Gate of Libyan Warehouse	Paver Block	Good	80	NA	No treatment needed. Only side concrete beams to be	40 MA/SMA after two years

Table 10	6. Strengthening	<b>Recommendations</b>	for the	Roads of the Netwo	ork

Road No.	Name of the Road	Existing Surfacing	Existing Condition	Estimated Traffic for 10 Yr Design Life (msa)	Characteristic Deflection (mm)	Recommended Treatment (mm)	Remarks
						repaired wherever damaged	
8	ConnectingRoadbetween TaratalaRoadto Sick line (Paharpur)Road	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
9	Old Garagacha Road	Bituminous	Fair	80	1.00	50 DBM + 40 MA/ SMA	Shoulders may be laid with paver block
10	New Taratala Road	Bituminous	Fair	80	0.80	40 MA/ SMA	PCC to be done with DBM
11	Old Taratala Road	Bituminous	Fair	80	0.80	40 MA/ SMA	PCC to be done with DBM
10	Transport Depot Road and Transport Depot Road Bypass upto level crossing	Bituminous	Fair	80	1.00	50 DBM + 40 MA/ SMA	Nil
12		Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
13	Helen Killer Sarani	Bituminous (recently done)	Good	55	0.70	40 MA/ SMA	Present traffic is low because of bridge collapse but anticipated to increase

Road No.	Name of the Road	Existing Surfacing	Existing Condition	Estimated Traffic for 10 Yr Design Life (msa)	Characteristic Deflection (mm)	Recommended Treatment (mm)	Remarks
14	Remount Road	Bituminous	Poor	55	1.50	75 DBM + 40 MA/ SMA	Nil
15	Durgapur yard Road	Granular	Poor	NA	NA	150 DLC + 330 PQC	Existing layers may be retained
16	Garagcha Road	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
17	Mint Place Road	Bituminous	Fair	15	1.0	40 MA/ SMA	Nil
18	Low Level Bypass Road on both side of Brace Bridge	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
20	Cross Road connecting CGR Road and Brooklyn Depot (Singherhati Road)	Bituminous	Fair	55	0.80	40 MA/ SMA	Nil
21	Subhas Nagar Road from CGR Road to Dhobi Tala Connector Road	Bituminous	Fair	55	0.80	40 MA/SMA	Nil
		Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa

Road No.	Name of the Road	Existing Surfacing	Existing Condition	Estimated Traffic for 10 Yr Design Life (msa)	Characteristic Deflection (mm)	Recommended Treatment (mm)	Remarks
							PQC: M40 Grade
23	Road from Hide Road leading towards JJP Area	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
25	Road leading to Centenary Hospital	Bituminous	Good	55		No treatment	40 MA/SMA after two years
26	Hide Road & Hide Road Extension	Bituminous (Recently done)	Fair	80	1.00	50 DBM + 40 MA/ SMA	Nil
		Approaches to Level Crossing	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
30	Dock East Boundary Road	Bituminous	Fair	80	1.00	50 DBM + 40 MA/ SMA	Nil
31	Haboken Road	Granular	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
32	Dock West Boundary Road	Bituminous	Fair	5	1.0	40 MA/ SMA	Nil

Road No.	Name of the Road	Existing Surfacing	Existing Condition	Estimated Traffic for 10 Yr Design Life (msa)	Characteristic Deflection (mm)	Recommended Treatment (mm)	Remarks
33	New Road connecting Taratola Road to Dhobitola /Sonarpur Road	Bituminous Base Failure	Poor	NA	NA	150 GSB + 150 DLC + 330 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade
ALLEY	Y ROADS	Granular/Bituminous	Poor	NA	NA	150 GSB + 150 DLC + 280 PQC	DLC: 7 Day Comp. Strength of 10 MPa PQC: M40 Grade

DBM: Dense Bituminous Macadam, MA: Mastic Asphalt, SMA: Stone Matrix Asphalt, PCC: Profile Correction Course GSB: Granular Sub-base, DLC: Dry Lean Concrete, PQC: Pavement Quality Concrete

#### 5. GENERAL RECOMMENDATIONS

Besides the specific recommendations made for strengthening and resurfacing of project roads, the following general recommendations are also being made, which need to be considered during the execution of road works:

- Before providing the recommended resurfacing treatments, the existing bituminous surface shall be corrected for various surface distress/defects by filling the cracks, potholes and settlement/undulations etc. No part of the thickness of treatment recommended shall be used for correcting the surface irregularities
- 2. It appears that Profile Correction Course (PCC) may not be needed for all the project roads. However, for the roads where PCC is required, the exact requirements may be assessed/decided by the officials of Kolkata Port Trust prior to the execution stage, as the case may be. The profile correction course, if required at all, is to be applied after filling the cracks, potholes, settlements/deformations/undulations etc.
- 3. The Dense Bituminous Macadam suggested for Profile Correction Course shall be properly designed in the laboratory before laying in the field. In that case VG-40 binder shall be used for production of the bituminous mixes, since the project roads are subjected to more than 30 MSA traffic during the design life of resurfacing treatments. The mix composition shall be regularly checked for gradation, binder content, stability, flow and air voids etc.
- 4. Mastic Asphalt is recommended for resurfacing of roads shall be properly designed in the laboratory before its laying in the field. 25/85 industrial grade bitumen shall be used for production of Mastic Asphalt mix.
- 5. As a substitute of Mastic Asphalt, it is recommended to use Stone Matrix Asphalt (SMA) for resurfacing of roads. If Kolkata Port Trust use SMA as resurfacing/overlay of existing flexible pavements PMB-40 binder with good quality Cellulose Fibre may be used as per guidelines of IRC: SP-79-2008 "Tentative Specifications for Stone Matrix Asphalt".
- 6. A tack coat of Cationic Bitumen Emulsion Rapid Setting (RS-I) or VG-10 bitumen is to be applied @ 2.5 Kg to 3.0 Kg per 10 sqm at the interface of two bituminous layers.

- 7. A camber of 2.5 % on the carriageway shall be maintained for quick runoff of surface water.
- 8. The longitudinal profile shall be so adopted as to avoid the jerks at cross drainage structures due to sudden change in levels.
- Suitable and adequate drainage measures shall be ensured for proper draining off surface and sub-surface water. The utility services need to be regularly checked to avoid leakage of pipe/drains etc. This is most important for long term durability and better performance of flexible roads.
- 10. Strict quality control and supervision shall be maintained for temperature of mix at the time of production, during laying of hot mixes at site and rolling at site, while constructing the bituminous layers.
- 11. For all the specifications "Specifications of Road and Bridge Works" MoRTH, 2013 (5th Revision) shall be applied.

#### 6. **RIGID PAVEMENT**

The roads of the network which were observed to be in poor condition during field investigations have been recommended to be strengthened / improved by constructing cement concrete roads also called rigid pavement. Roads which have been recommended for rigid pavement are Road Nos. 2, 4, 8, part of 12, 15, 16, 18, part of 21, 23, part of 26, 31, 33 and Alley Road. All of the roads recommended for rigid pavement, except Road No. 15 (Durgapur Yard Road), have to be constructed right from the construction of at least 500 mm thick subgrade followed by the placement of Granular Sub base (GSB), Dry Lean Concrete (DLC), Polythene Sheet, and Pavement Quality Concrete (PQC). For Road No. 15, existing layers may be retained and overlaid by DLC. Rigid pavement has been designed for a design life of 30 years and for a minimum CBR of 4 % which was determined in the laboratory for the local soil samples collected from the field. Recommendations for different roads is given in Table 16.

#### 6.1. DESIGN SUMMARY

Granular Sub Base Drainage Layer	150 mm
Dry Lean Concrete Layer (7 Days compressive strength – 10 MPa)	150 mm
Polythene Sheet Separation Membrane	150 micron
Pavement Quality Concrete (M40 Grade) (28 Days Flexural Strength of 4.5 MPa)	270 mm
Spacing of Contraction Joint	4.5 m
Width of the PQC Slab	3.5 m
Camber in Transverse Direction	1.5%

### **Dowel Bars at Each Transverse Joint**

38 mm dia, 500 mm long, plain mild steel dowel bars to be provided at each transverse contraction and construction joint at a spacing of 230 mm c/c. The dowels shall be provided with plastic sheath with closed end over 300 mm length. The thickness of sheath shall not exceed 0.50 mm.

For ALLEY Roads, 32 mm dia, 500 mm long, plain mild steel dowels to be provided at a spacing of 250 mm c/c.

### Tie Bars at longitudinal joints

12 mm dia, 640 mm long, deformed tie bars to be provided at each longitudinal joint at a spacing of 540 mm c/c.

For ALLEY Roads, 12 mm dia, 640 mm long deformed tie bars to be provided at a spacing of 640 mm c/c.

Cross-section details are given in Fig. 8



Fig. 8 Cross Section of Rigid Pavement

### 6.2 Details of Different Layers and Joints

### 6.2.1 Granular Sub-Base cum Drainage Layer

The drainage layer is intended to drain off the water that seeps into the bottom of the pavement through cracks and joints. Granular sub-base (GSB) cum drainage layer shall be laid and compacted using well graded material on prepared subgrade as per the method mention in clause 401 of MORTH specifications, 2013. It will be constructed with material conforming to Grading III of Table 400-1 of MORTH specifications, reproduced below in Table 17.

IS Sieve Designation	Percent by Weight Passing the IS Sieve
53.0 mm	100
26.5 mm	55 – 75
4.75 mm	10 – 30
0.075 mm	Less than 5

#### Table 17. Grading for Granular Sub-Base cum Drainage Layer

### 6.2.2 Dry Lean Concrete

Dry lean Concrete (DLC) layer of 150 mm thickness will be laid over GSB layer. The work of laying DLC shall conform to clause 601.1 of MORTH Specifications. DLC shall be a concrete with a maximum aggregate to cement ratio of 15 : 1 with minimum cement content of 150 kg /m<sup>3</sup>. Compressive strength of DLC shall be 10 MPa (100 kg/cm<sup>2</sup>) at 7 days. The optimum water content which generally varies from 5 to 7 percent of total weight of dry aggregates including cement, should be so selected by field trials as to ensure full compaction under rolling. The DLC layer shall extend on both sides beyond concrete slabs minimum by 300 mm wherever possible. Dry lean concrete shall be compacted to the required lines, levels and cross-section by means of 8-10 T smooth wheel static or preferably vibratory rollers and it shall be cured for minimum 7 days. The gradation of aggregates for DLC is given in Table 18.

IS Sieve	Percent Passing by Weight
26.50 mm	100
19.00 mm	80 - 100
9.50 mm	55 - 75
4.75 mm	35 - 60
600 micron	10 - 35
75 micron	0 - 8

Table 18. Aggregate Gradation for Dry Lean Concrete

#### 6.2.3 Separation membrane

A separation membrane shall be provided between DLC and pavement quality concrete in the form of a polythene sheet having thickness of 150 micron and extending over full width of DLC. It shall be spread
properly over DLC without any wrinkles or folds. Polythene sheet should be of light colour and not black.

### 6.2.4 Pavement Quality Concrete

Pavement Quality Concrete (PQC) shall be of 330 mm thickness and M40 Grade with 28 days flexural strength not less than 4.5 MPa. The slump of the concrete for semi-mechanized construction using screed and needle vibrator should be around 40-50 mm. However, if concrete is to be laid with slip form paver then required slump should be around 20-25 mm. Concrete of required strength and workability shall be procured from a Ready Mix Concrete (RMC) plant or prepared in weigh batching plant erected at site.

### 6.2.5 Contraction Joints

Transverse contraction joints permit the slab to contract and act as breaks in the continuity of the slab to prevent irregular cracking. Saw cut contraction joints shall be provided at each 4.5 m distance with mild steel round dowel bars. Plain dowel bars of 38 mm diameter and having length of 500 mm shall be provided at a spacing of 230 mm c/c. For ALLEY Roads, 32 mm dia, 500 mm long, plain mild steel dowels shall be provided at a spacing of 250 mm c/c. First dowel bar shall be placed at a distance of 150 mm from the pavement edge. Dowel bars shall be covered by a thin plastic sheath for 60 % of the length from one end. The thickness of sheath shall not exceed 0.50 mm. Initially 3-4 mm wide cut shall be made up to a depth of 110 mm (90 mm for Alley Road) and then, at the time of sealing the joint, a sealing groove shall be inserted to the bottom of the groove. The groove then shall be filled with polysulphide/polyeurethene/silicon sealant as per IRC: 15 - 2017. Sealant shall be applied slightly to a lower level than the top of the slab with a tolerance of  $3 \pm 1$  mm. The contraction joint details are given in Fig. 9.

# 6.2.6 Longitudinal Joints

Longitudinal joints are required between two adjacent concrete slabs in longitudinal direction. Tie bars shall be provided at the longitudinal joints between two slabs. Deformed 12 mm dia mild steel tie bars of length 640 mm shall be provided at a spacing of 540 mm. For ALLEY Roads, 12 mm dia, 640 mm long deformed tie bars shall be provided at a spacing of 640 mm c/c. Tie bars projecting across the

longitudinal joint shall be protected from corrosion for 75 mm on each side of the joint by a protective coating of bituminous paint. Sealant reservoir groove shall be prepared as per details given in Fig. 10. Before sealing the joint 2 mm thick compressible debonding strip with paperback shall be inserted to the bottom of the groove. The groove then shall be filled with polysulphide/polyeurethene/silicon sealant. Sealant shall be applied slightly to a lower level than the top of the slab with a tolerance of  $3 \pm 1 \text{ mm}$ . The longitudinal joint details are given in Fig. 10.



CONTRACTION JOINT WITH DOWEL BAR



## CONTRACTION JOINT

Fig. 9. Contraction Joint Details



LONGITUDINAL BUTT JOINT WITH TIE-ROD BETWEEN TWO LANES



Note: All DIM. IN mm.

## LONGITUDINAL JOINT

### Fig. 10. Longitudinal Joint Details

# 6.2.7 Construction Joints

Construction joint (Fig. 11) shall be provided at the end of a day's work or when the work is stopped unexpectedly for more than 30 minutes due to interruptions at any point. Except in the case of emergency, construction shall always be suspended at the regular site of contraction joint. Construction joint shall be butt type joint with dowels. Plain dowel bars of 32 mm diameter and having length of 500 mm shall be provided at a spacing of 230 mm c/c. For ALLEY Roads, 32 mm dia, 500 mm long, plain

mild steel dowels shall be provided at a spacing of 250 mm c/c. First dowel bar shall be placed at a distance of 150 mm from the pavement edge. Dowel bars shall be covered by a thin plastic sheath for at least 60 percent of the length from one end. Sealing groove shall be made with the help of saw cut machine as per Fig. 11. Before sealing the joint a 5 mm thick compressible debonding strip with paperback shall be inserted to the bottom of the groove. The groove then shall be filled with polysulphide/polyurethene/silicon sealant. Sealant shall be applied slightly to a lower level than the slab with a tolerance of  $3 \pm 1$  mm.



CONSTRUCTION BUTT JOINT WITH DOWEL BAR



Note: All DIM. IN mm.

### CONSTRUCTION JOINT



# 6.3 Construction Guidelines

- The existing layer shall be removed and construction of rigid pavement shall start by providing well compacted 500 mm thick subgrade before placing layer of GSB.
- GSB layer of 150 mm thickness shall be provided over the compacted subgrade. The GSB layer shall be finished with required camber and grade.
- 150 mm thick DLC layer shall be laid over moistened GSB to the required camber and grade. The DLC should extend beyond the overlaying PQC by 300 mm on both sides wherever possible.
- The pavement quality concrete shall preferably be laid using a slip form paver fitted with dowel and tie bar inserter units. In case slip form paver is not used then PQC shall be laid and compacted by fixed form paver. If concrete is paved with fixed form paver, then, dowel bars shall be placed on chairs fabricated with steel rebars. The PQC shall be laid in strips of 3.5 m width each and having camber of 1.5% in opposite direction. The width of the strip may be changed as per the paving width of the road. In any case, it should not be more than 4.5 m. Tie bars at the longitudinal joints between two strips/lanes shall be provided at the time of laying first strip by using a longitudinal form work having holes of appropriate size and spacing as per the design recommendation of tie bars.
- PQC mix shall be prepared in a concrete batching plant having accurate mechanism for weighing the ingredients.
- The normal size of the slabs shall be 4.5 m x 3.5 m for 7 m wide carriageways. However, it
  may be adjusted as per the paving width of the road. Layout of transverse and longitudinal
  joints is given in Fig. 12.
- Texturing of the concrete pavement shall be achieved by tining the finished concrete surface in transverse direction by using rectangular steel tines. The tined grooves shall be



3 mm wide and 3 to 4 mm deep. Alternatively, the brush or broom texturing may also be applied.

Fig. 12. Layout of Transverse and Longitudinal Joints

 Immediately after the completion of finishing and brooming operations, the initial curing may be performed by using some suitable curing compound or by covering the entire surface of the freshly laid concrete with wet hessian cloth or plastic sheet to avoid evaporation of water during initial 3-4 hours. Afterwards, the curing of concrete either by ponding or wet hessian cloth shall continue minimum for 14 days.

- Joints shall be cut with a diamond cutter within 8-10 hours to 24 hours after laying the concrete. The exact time of cutting the joints shall be such that no ravelling occurs while cutting the joints. After making an initial cut of 3 4 mm width and 110 mm depth (90 mm for Alley Roads), the joint shall be filled with a jute rope to avoid ingress of sand, grit, etc. into the joint. This jute rope shall be taken out at the time of making sealant groove for sealing the joint with some sealant. All the joints shall be sealed with polysulphide sealant before opening the road to traffic.
- Drains should be provided on both sides of the road. Wherever the drains exists, they should be cleaned regularly to keep then in running condition.
- For further guidance on the construction of concrete road, MORTH Specifications for Road & Bridge Works, 2013 (fifth revision), and IRC: 15 - 2017 - Code of Practice for Construction of Jointed Plain Concrete Pavements, shall be referred.







LEVEL ROAD ON THE BRACE BRIDGE FROM BRIDGE APPROACH





