Section 7
Design of Structures

SECTION 7

DESIGN OF STRUCTURES

7.1 General

(i) All new structures up to 60 m length shall be constructed with an overall width between outermost faces of the railings/parapets/crash barriers equal to the roadway width of the approaches.

(ii) All new structures more than 60 m length shall have minimum 7.5 m wide carriageway, unless specified otherwise in Schedule-B of the Concession Agreement.

(iii) New structures with footpaths, where so specified in Schedule-B of the Concession Agreement, shall be constructed with an overall width of 12 m between the outermost faces of the crash barriers or railings. Raised footpaths shall be provided.

(iv) All bridges shall be high level bridges, unless specified otherwise in the Concession Agreement.

(v) All structures shall be designed in accordance with the relevant IRC Codes, Standards and Specifications.

(vi) All railway level crossings (except railway sidings) shall be replaced with ROBs/RUBs, unless specified otherwise in Schedule-B of the Concession Agreement.

(vii) Typical cross sections of the new culverts and bridges for a 2-lane highway are given in Figs. 7.1 to 7.4.

(viii) Any utility services to be taken on the structures shall be specified in Schedule-B of the Concession Agreement.

7.2 Design Loading and Stresses

(i) The design loads and stresses shall be as per IRC:6.

(ii) Raised footpath shall be provided in built up areas.

(iii) In Seismic Zones IV and V, necessary design related precautions against dislodgement of superstructure shall be taken as per Clause 222 of IRC:6.

(iv) All the components of structures shall be designed for a service life of 100 years except appurtenances like crash barriers, wearing surface and rubberized components in expansion joints and elastomeric bearings. All the requirements to achieve durability and serviceability shall be implemented.

(v) For bridges in marine environment, special precautions as specified in Schedule-B of the Concession Agreement shall be taken. (Refer para 7.22)

7.3 Widening / Reconstruction of Existing Structures

7.3.1 *Existing Culverts*

(i) All culverts which are structurally distressed shall be specified in

Schedule-B of the Concession Agreement and shall be reconstructed as new structures.

(ii) All existing culverts which are not to be reconstructed shall be widened equal to the roadway width of approaches.

7.3.2 *Existing Bridges*

(i) All the bridges which are structurally distressed shall be specified in Schedule-B of the Concession Agreement and shall be reconstructed as new structures.

(ii) The bridges which are sound but narrower than 7.5 m width (carriageway) shall be widened where specified in Schedule-B of the Concession Agreement.

(iii) All existing bridges in sound condition with 7.5 m wide carriageway shall be retained.

7.4 Structure Types

(i) Bridge superstructure may be of reinforced concrete, pre-stressed concrete or steel-concrete composite construction.

(ii) Wherever box girders are proposed for superstructure, the minimum clear depth inside the box shall be 1.50 m with suitable openings in the diaphragms and box to facilitate inspections. Haunches of minimum size of 300 mm (horizontal) and 150 mm (vertical) shall be provided at the extreme corners of the box section.

(iii) Bridge foundation and substructure shall be of masonry or plain or reinforced concrete. These will be designed as per the relevant IRC Codes/ MOSRTH Specifications.

(iv) Innovative structures like continuous bridges, precast pre-tensioned girder bridges and segmental bridges may be adopted, where considered appropriate. The design of continuous bridges shall be governed by IRC:SP:66. Design of segmental bridges shall be governed by IRC:SP:65 and design of pre-cast pre-tensioned girder bridges shall be governed by IRC:SP:71.

7.5 Hydrology

All the structures shall have adequate waterway. The design discharge shall be evaluated for flood of 50-year return period.

7.6 Sub-Surface Investigations

7.6.1 The Concessionaire shall carry out independent sub-surface investigations to establish the soil parameters required for detailed design of each foundation separately, if necessary, in accordance with relevant provisions of IRC:78 and MOSRTH Specifications.

7.6.2 For single span structures (bridges, overpasses, ROBs etc.), bores shall be taken at each of the abutment locations. For structures having more than one span, at least one bore shall be taken at each of the foundation locations.

7.7 Culverts

7.7.1 *New Culverts*

Reinforced concrete pipes for culverts shall be of NP 4 type, conforming to the requirements of IS: 458. Minimum diameter of pipes for new pipe culverts shall be 1200 mm (Internal diameter).

7.7.2 *Existing Culverts*

(i) Existing pipe culverts of diameter 900 mm and above, which are in sound condition and functioning satisfactorily, may be extended using pipes of same diameter.

(ii) All culverts having pipe diameter less than 900 mm shall be replaced with pipes of minimum 1200 mm diameter.

(iii) (a) Suitable bedding for pipes shall be provided as per Clause 2904 of MOSRTH Specifications

(b) Minimum cushion of 600 mm shall be provided for pipe culverts.

(iv) Floor protection shall be as specified in the relevant IRC Specifications.

7.8 Prestressing

(i) The Concessionaire shall engage specialized agency in consultation with Independent Engineer for rendering total service contract. The Concessionaire shall also obtain the necessary certificate from the specialized agency engaged, that the work has been carried out in accordance with the prescribed standards and specifications.

(ii) The Concessionaire shall submit fabrication drawings, detailing of prestressing cables, anchorages, couplers, chairs and supports, templates or forms for holding anchorage assemblies, stressing schedule, etc for review and comments of Independent Engineer, if any, at least 45 days prior to the scheduled date of commencement of the prestressing work.

(iii) The sheathings shall be either in mild steel as per clause 3.6.1 or HDPE as per clause 3.6.2 of IRC:18. They shall comply with the requirements specified in Appendix 1A/1B of IRC:18 and the Concessionaire shall obtain a test certificate of confirmation from the manufacturer and furnish for review and comments of Independent Engineer, if any, before bringing the proposed type of sheathing to the site.

(iv) In order to keep the number of joints in a duct to the minimum possible, the sheathings shall be as long as practical from handling and transportation considerations without getting damaged. Sheathing damaged during handling or transportation shall not be made good and used in the works.

(v) The joints of the mild steel sheathings shall be water tight complying with the requirements given in Appendix 2 of IRC:18.

(vi) Pull-in or push-in of the prestressing strands shall be mechanized.

(vii) Temporary tendons shall be inserted in the sheathing or the sheathing shall be stiffened by other suitable method during concreting. Cables shall be threaded after the concreting. Tendons shall not be placed until immediately prior to stressing. Tendons shall be handled with care to avoid damage or contamination, to either tendon or the sheathing. Any tendon damaged or contaminated shall be cleaned or replaced.

(viii) Prestressing accessories like jacks, anchorages, wedges, block plates, couplers etc being patented items shall be obtained from only authorized

manufacturers with in-house testing facilities.

(ix) All prestressing components and accessories shall be subject to acceptance tests and reviewed prior to their actual use on the works. Testing of anchorage cable assemblies shall be carried out in consultation with Independent Engineer. Couplers which connect two tendons to form a continuous tendon shall be tested in the same way as anchorages formed by mechanical means.

(x) Jacks and pumps shall be got calibrated from any accredited laboratory prior to use and then at intervals not exceeding three months.

(xi) Grouting shall be carried out as early as possible, but not later than 10 days of stressing of a tendon. Grouting of post-tensioned cables shall be carried out as per the recommended practice specified in Appendix 5 of IRC:18.

(xii) Jointing of pre-cast units by application of cement mortar shall not be permitted. The Concessionaire shall submit adequate data in support of the proposed method of jointing the pre-cast units for the review and comments of Independent Engineer, if any.

Whatever may be the method of jointing, the holes of prestressing steel shall be accurately made to meet one another in true alignment at ends and to ensure even transfer of compression from one unit to another.

(xiii) Care shall be taken to ensure that the jointing material does not enter the duct or press the sheath against the prestressing steel.

(xiv) Guidelines for use of external and unbonded prestressing tendons in bridge structures can be considered as per IRC:SP:67, wherever considered appropriate.

7.9 Form Work

The Concessionaire shall be responsible for the safe, workable design and methodology for all temporary or permanent forms, staging and centering required for supporting and forming the concrete of shape, dimensions and surface finish as shown on the drawings. The following guidelines shall be adopted:

(i) Only steel formwork shall be permitted.

(ii) Shuttering oil (release agent) used shall be such, which permits easy removal of shutters without leaving stains or other marks on the surface of the concrete. Requirements given under Clause 3.5 of IRC:87 shall also be complied with.

(iii) In case of tubular staging of heights more than 10 m, special attention shall be paid to the structural adequacy of the system, efficacy of the connections (clamps etc), and foundations. Foundation blocks of adequate thickness in M15 cement concrete shall be provided under the base plates to prevent unequal settlements. All bent tubular props shall be straightened before re-use and the member with deviation from straightness more than 1 in 600 of its length shall not be re-used. For re-used props, suitable reduction in the permissible loads shall be made depending upon their condition in accordance with recommendations of the manufacturer and as reviewed by Independent Engineer.

(iv) In case of prestressed concrete members, the side forms shall be removed as early as possible and the soffit forms shall permit movement of member without restraint, when prestress is applied. Form supports and forms for cast-in-situ members shall not be removed until sufficient prestress has been applied to carry all anticipated loads during construction stage.

7.10 Foundations and Sub-structures

7.10.1 The design of foundations and sub-structures shall conform to IRC:78.

7.10.2 *Open Foundations*

The design of open foundations shall conform to IRC:78. Floor protection shall be provided as per Section 2500 of MOSRTH Specifications.

7.10.3 *Pile Foundations*

(a) The construction of pile foundation in bridges has been introduced rather recently. The design of pile foundations shall be done as per specialized literature and IRC:78. The Concessionaire shall submit a method statement to Independent Engineer for review and comments, if any. The method statement shall be supported by the following:

(i) Bore-log details for each foundation;

(ii) Design assumptions;

(iii) Design calculations both for new pile or group of piles and for pile type;

(iv) Type of piles- Bored cast-in-situ piles, driven piles and girder piles;

(v) Procedure adopted for installation of piles;

(vi) Arrangements for load testing of piles;

(vii) Format for reporting of tests results.

(b) The Concessionaire shall submit the following information to Independent Engineer for review and comments, if any, regarding proposed proprietary system of piling:

(i) Diameter, length and type of pile proposed for the structure;

(ii) General features of the process/system along with specifications and standards;

(iii) Authenticated copies of license/ agreement, if any;

(iv) Details of plant and equipment to be used along with the names of manufacturers and name of process/ system;

(v) Details of projects where the process/ system has been successfully used;

(vi) Limitations, if any;

(vii) Acceptance tests and criteria;

(viii) Installation & maintenance procedure and schedule;

(ix) Performance Warranty

7.10.4 *Well Foundations*

(a) For conventional method of well sinking, the Concessionaire shall submit a method statement to Independent Engineer for review and comments, if any, including the following:-

(i) Design calculations and drawings,

(ii) Procedure for sinking and plugging of well,

(iii) Format for reporting of test results.

(b) If proprietary system of well sinking like jack down method is proposed to be used, the Concessionaire shall submit relevant information to Independent Engineer for review and comments, if any, covering the following inter-alia:

(i) General features of the system along with specifications and standards and justification for the thickness of steining proposed to be adopted;

(ii) Authenticated copies of license/ agreement, if any;

(iii) Details of plant and equipment to be used along with the names of manufacturers and name of process/ system;

(iv) Details of projects where the system has been successfully used;

(v) Limitations, if any;

(vi) Acceptance tests and criteria;

(vii) Installation & maintenance procedure and schedule;

(viii) Performance Warranty

7.11 Approach Slabs

Approach slab shall be provided as per provision in Clause 217 of IRC:6 and Section 2700 of MOSRTH Specifications.

7.12 Superstructures

7.12.1 The design of reinforced and prestressed concrete super structures shall be as per IRC:21 and IRC:18 respectively. The design of steel and steel-concrete composite super structures shall conform to IRC:22 and IRC:24 respectively.

7.12.2 The Concessionaire shall submit the Method Statement to Independent Engineer for review and comments, if any, indicating the following inter alia:

(i) Sources of materials,

(ii) Design, erection and removal of formwork,

(iii) Layout of casting yard together with necessary details,

(iv) Production, transportation, laying and curing of concrete,

(v) Sequence of concreting in cast-in-situ construction, side shifting of girders, if applicable and placing of girders on the bearings,

(vi) Details of construction joints,

(vii) Prestressing system, if required,

(viii) Methodology and equipment for side shifting and launching of pre-cast girders,

(ix) Key personnel for execution and supervision,

(x) Testing and sampling procedure,

(xi) Equipment details.

7.13 Bearings

7.13.1 All bearings shall be easily accessible for inspection, maintenance and replacement. Design and specifications of bearings shall be as per IRC:83 (Part I, II & III). Spherical bearings shall conform to the requirements of BS: 5400. The materials of bearings may, however, conform to the relevant BIS codes nearest to the specifications specified in BS: 5400. The drawing of bearings shall include

the layout plan showing exact location on top of pier and abutment cap and the type of bearings i.e. fixed/free/rotational at each location along with notes for proper installation.

7.13.2 The Concessionaire shall procure bearings only from the manufacturers approved by MOSRTH.

7.13.3 The Concessionaire shall submit detailed specifications, designs and drawings including installation drawings and maintenance manual incorporating the replacement procedure to the Independent Engineer for review and comments, if any.

7.13.4 The Concessionaire shall obtain a complete Quality Assurance Programme (QAP) from the manufacturer for the review and comments, if any, by Independent Engineer. The QAP shall give full details of the process of quality control, raw material testing, various stages of manufacture, testing on bearing components as well as testing on complete bearing in conformity with relevant part of IRC:83 prior to the commencement of manufacture of the bearings.

7.13.5 In addition to the routine testing of the materials and bearings at the manufacturer's premises, the Concessionaire shall arrange testing of random samples of one per cent (minimum one number of each type) of bearings from independent agency approved by Independent Engineer. The bearings shall be selected by Independent Engineer and duly sealed in his presence for dispatch to the approved independent agency.

7.13.6 The Concessionaire shall submit a certificate of confirmation regarding quality control measures taken during manufacture of the bearings and the material conforming to the prescribed standards and specifications. Full lot of bearings of the sample found to have inferior specifications to those certified by the manufacturer or to have a major discrepancy in material specifications or fail to meet the acceptance criteria, shall be rejected.

7.14 Expansion Joints

i) Structures shall have minimum number of expansion joints. This may be achieved by adopting longer spans, making the superstructure continuous or using integrated structures. Expansion joints shall conform to IRC: SP:69. The Concessionaire shall furnish guarantee/proprietary indemnity bonds from the manufacturers/suppliers of expansion joints for a period of 10 years.

ii) Rubberized components of expansion joints of all the existing structures older than 15 years shall be replaced.

7.15 Wearing Coat

i) The wearing coat shall be cement concrete in case of curved bridges and box girder bridges, in other cases it may be either bituminous concrete or cement concrete. The wearing coat shall have two directional camber and shall be in conformity with Section 2700 of MOSRTH Specifications

ii) Wearing coat in damaged/distressed condition shall be replaced by bituminous wearing coat.

7.16 Reinforced Earth Retaining Structures

7.16.1 Reinforced earth retaining structures shall not be provided for height more than 6 m and near water bodies. Such structures should be given special attention in design, construction, maintenance and selection of system/system design.

(b) If proprietary system of well sinking like jack down method is proposed to be used, the Concessionaire shall submit relevant information to Independent Engineer for review and comments, if any, covering the following inter-alia:

(i) General features of the system along with specifications and standards and justification for the thickness of steining proposed to be adopted;

(ii) Authenticated copies of license/ agreement, if any;

(iii) Details of plant and equipment to be used along with the names of manufacturers and name of process/ system;

(iv) Details of projects where the system has been successfully used;

(v) Limitations, if any;

(vi) Acceptance tests and criteria;

(vii) Installation & maintenance procedure and schedule;

(viii) Performance Warranty

7.11 Approach Slabs

Approach slab shall be provided as per provision in Clause 217 of IRC:6 and Section 2700 of MOSRTH Specifications.

7.12 Superstructures

7.12.1 The design of reinforced and prestressed concrete super structures shall be as per IRC:21 and IRC:18 respectively. The design of steel and steel-concrete composite super structures shall conform to IRC:22 and IRC:24 respectively.

7.12.2 The Concessionaire shall submit the Method Statement to Independent Engineer for review and comments, if any, indicating the following inter alia:

(i) Sources of materials,

(ii) Design, erection and removal of formwork,

(iii) Layout of casting yard together with necessary details,

(iv) Production, transportation, laying and curing of concrete,

(v) Sequence of concreting in cast-in-situ construction, side shifting of girders, if applicable and placing of girders on the bearings,

(vi) Details of construction joints,

(vii) Prestressing system, if required,

(viii) Methodology and equipment for side shifting and launching of pre-cast girders,

(ix) Key personnel for execution and supervision,

(x) Testing and sampling procedure,

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the layout plan showing exact location on top of pier and abutment cap and the type of bearings i.e. fixed/free/rotational at each location along with notes for proper installation.

7.13.2 The Concessionaire shall procure bearings only from the manufacturers approved by MOSRTH.

7.13.3 The Concessionaire shall submit detailed specifications, designs and drawings including installation drawings and maintenance manual incorporating the replacement procedure to the Independent Engineer for review and comments, if any.

7.13.4 The Concessionaire shall obtain a complete Quality Assurance Programme (QAP) from the manufacturer for the review and comments, if any, by Independent Engineer. The QAP shall give full details of the process of quality control, raw material testing, various stages of manufacture, testing on bearing components as well as testing on complete bearing in conformity with relevant part of IRC:83 prior to the commencement of manufacture of the bearings.

7.13.5 In addition to the routine testing of the materials and bearings at the manufacturer's premises, the Concessionaire shall arrange testing of random samples of one per cent (minimum one number of each type) of bearings from independent agency approved by Independent Engineer. The bearings shall be selected by Independent Engineer and duly sealed in his presence for dispatch to the approved independent agency.

7.13.6 The Concessionaire shall submit a certificate of confirmation regarding quality control measures taken during manufacture of the bearings and the material conforming to the prescribed standards and specifications. Full lot of bearings of the sample found to have inferior specifications to those certified by the manufacturer or to have a major discrepancy in material specifications or fail to meet the acceptance criteria, shall be rejected.

7.14 Expansion Joints

i) Structures shall have minimum number of expansion joints. This may be achieved by adopting longer spans, making the superstructure continuous or using integrated structures. Expansion joints shall conform to IRC: SP:69. The Concessionaire shall furnish guarantee/proprietary indemnity bonds from the manufacturers/suppliers of expansion joints for a period of 10 years.

ii) Rubberized components of expansion joints of all the existing structures older than 15 years shall be replaced.

7.15 Wearing Coat

i) The wearing coat shall be cement concrete in case of curved bridges and box girder bridges, in other cases it may be either bituminous concrete or cement concrete. The wearing coat shall have two directional camber and shall be in conformity with Section 2700 of MOSRTH Specifications

ii) Wearing coat in damaged/distressed condition shall be replaced by bituminous wearing coat.

7.16 Reinforced Earth Retaining Structures

7.16.1 Reinforced earth retaining structures shall not be provided for height more than 6 m and near water bodies. Such structures should be given special attention in design, construction, maintenance and selection of system/system design.

7.16.2 A qualified and experienced technical representative of the approved supplier/ manufacturer shall be present on site throughout during the casting and erection phases, to ensure that the quality of the works performed by the Concessionaire is in accordance with the specifications.

7.17 River Training and Protective Works

River training and protective works shall be provided wherever required, for ensuring the safety of bridges and their approaches on either side. The special features and design of various types of river training and protective works shall be in accordance with IRC:89.

7.18 Safety Barriers

(i) For bridges without foot paths, concrete crash barriers shall be provided at the edge of the carriageway on all new bridges.

(ii) The type design for the crash barriers may be adopted as per IRC:5. The design loading for the crash barriers shall be as per Clause 209.7 of IRC:6.

(iii) For bridges with foot paths, pedestrian railing shall be provided on the outer side of footpath.

(iv) The railings of existing bridges shall be replaced by crash barriers, where specified in Schedule-B of the Concession Agreement.

(v) Parapets/Railings of the existing bridges/culverts to be repaired/replaced shall be specified in Schedule-B of the Concession Agreement.

7.19 Rail-Road Bridges

7.19.1 ROB/RUB shall be provided on all railway level crossings, unless otherwise specified, in Schedule-B of the Concession Agreement

7.19.2 *Road Over Bridge (Road over Railway line)*

(i) In case the bridge is to be provided over an existing level crossing, 2-lane bridges shall be constructed with overall width as given in sub-para 7.1(i) of this Section. The horizontal and vertical clearances to be provided shall be as per requirement of the Railway authorities.

(ii) In general, the Railways require that in the railway boundary there is no solid embankment, provision is made for future expansion of railway line, provision of vertical clearances as per requirement of electric traction and excavation for foundations shall be sufficiently away so as not to endanger the safety of the running tracks.

(iii) The Concessionaire shall be required to obtain approvals of all designs and drawings from the concerned Railway authorities. The design of structure shall be in accordance with relevant IRC codes.

(iv) The construction of ROB within the Railway boundary shall be under the supervision of Railway officers.

(v) Approach gradient shall not be steeper than 1 in 40.

7.19.3 *Road under Bridges (Road under Railway line)*

(i) Full roadway width as in the approaches shall pass below the bridge structure. The service roads shall be continued in the bridge portion also.

(ii) The vertical and lateral clearances shall be as per guidelines given in Section 2 of this Manual.

(iii) These structures shall be designed to carry railway loads. The Concessionaire shall be required to obtain approvals of all designs and drawings from the concerned railway authorities. The design of structure shall be in accordance with relevant Railway codes.

(iv) The construction of RUB and its approaches shall be undertaken in conformity with the terms specified in the approval granted by the Railway authorities.

7.20 Grade Separated Road Structures

7.20.1 The location and type of grade separated road structures to be provided on the Project Highway shall be as specified in Schedule-B of the Concession Agreement.

7.20.2 The vertical and lateral clearances shall be as per requirements given in Section 2 of this Manual. Design of structures shall conform to the requirements specified in this Manual.

7.21 Drainage

An effective drainage system for the bridge deck structure shall be planned and designed so as to ensure that water from the deck is taken down to ground level/ drainage courses by adequate size of drainage spouts and pipes.

7.22 Structures in Marine Environment

Necessary measures/treatments for protecting bridges in marine environment shall be as specified in Schedule-B of the Concession Agreement.

7.23 Repairs and Strengthening

(i) Repairs and Strengthening of structures to be carried out shall be specified in Schedule-B of the Concession Agreement This shall be based on detailed condition survey of existing structures and shall bring out the nature and extent of repairs to be carried out, covering the following in addition to other specific requirements:-

(a) Repair/replacement of damaged railings and parapets, provision of crash barriers,

(b) Replacement of wearing coat (old wearing coat shall be removed and replaced by bituminous wearing coat),

(c) Replacement of expansion joints,

(d) Replacement of bearings,

(e) Structural repairs to substructure/super structure,

(f) Repair to flooring and protection works.

(ii) The Concessionaire shall submit repairs and strengthening plan for structures in para (i) above to Independent Engineer for review and comments, if any. For all other structures with minor deficiencies, not affecting structural inadequacies, appropriate repair measures may be proposed and submitted to Independent Engineer for review and comments, if any.

(iii) Strengthening/rehabilitation work shall be carried out in accordance with IRC:SP:40 or by any other acceptable method according to international practice.

(iv) The Concessionaire shall take up repair and widening of existing bridge at a particular site only after making all arrangement for diversion of traffic so as to ensure that a smooth flow of traffic is maintained. The

Concessionaire shall take all precautions to guard against any accident of traffic due to such diversion and shall use all necessary road signs, etc. for the purpose. After completion of repair and widening of the existing bridge, temporary works carried out for such diversions shall be made good by the Concessionaire.

7.24 Design Report

The Concessionaire shall furnish the design report including the following to the Independent Engineer for his review and comments, if any.

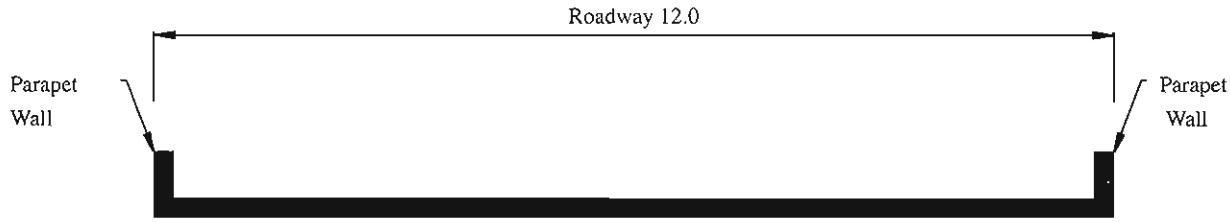
(i) Sub surface exploration report as per IRC:78 as specified in para 7.6 above.

(ii) Hydrological investigation report including design discharge calculation for the bridges, in case of any change in the proposed waterway of any bridge as specified in para 7.5 above.

(iii) Design and drawings of foundations, substructure and superstructure of structures.

(iv) Detailed report regarding the bridges whose width is less than the roadway width and the proposal for its improvement.

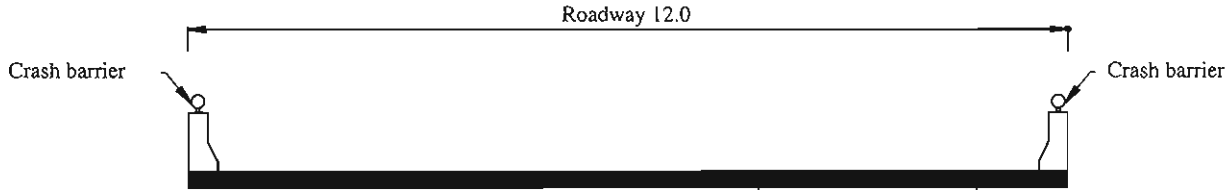
(v) Any other information relevant to the design report.



Note:
All dimensions are in metres.

Width of culvert at deck level
(Plain/rolling terrain)
2-lane carriageway

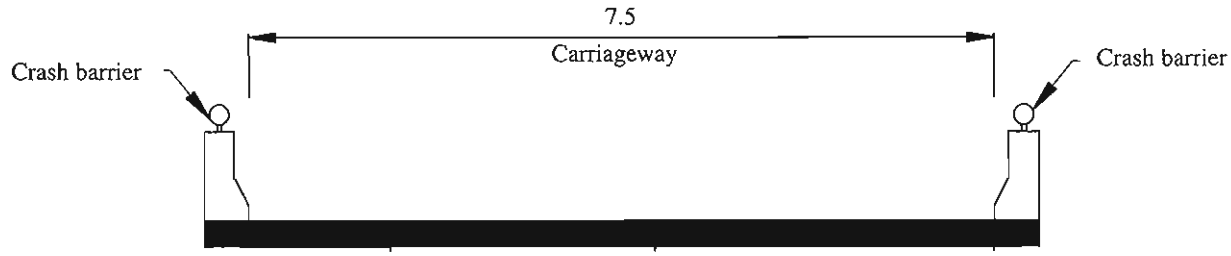
Fig. 7.1



Note:
All dimensions are in metres.

Width of bridge (without footpath) at deck level
(Plain/rolling terrain up to 60 m length)
2-lane carriageway

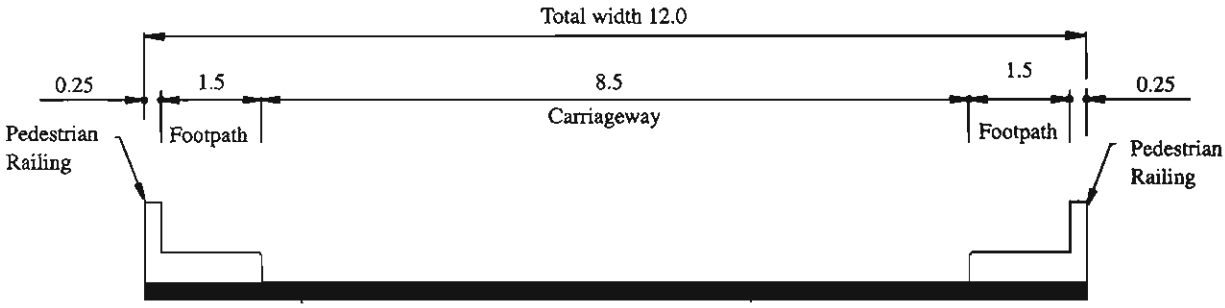
Fig. 7.2



Note:
All dimensions are in metres.

Width of bridge at deck level
(Bridges above 60 m length)
2-lane carriageway

Fig. 7.3



Note:
All dimensions are in metres.

Width of bridge at deck level
(Built-up area)
2-lane carriageway with footpath

Fig. 7.4