रेल भूमि विकास प्राधिकरण
Rail Land Development Authority
(रेल मंत्रालय, भारत सरकार का सांविधिक प्राधिकरण)
(A Statutory Authority under Ministry of Railways, Govt. of India)

No. RLDA/2023/Design Unit/DBR Correspondence/2863/Pt.2 **Dated:** 15.10.2024

Principal Chief Engineers
All Zonal Railways

Subject: Draft model Structural Design Basis report (DBR) for the design of Air Concourse and FOB for station redevelopment projects

Ref.: (i) Railway Board's letter no. 2024/SD-II/22/01/30 dated 04.07.2024
(ii) Railway Board's letter no. 2024/SD-II/22/01/30 dated 18.09.2024

Railway Board vide ref. (ii) advised RLDA for preparation of draft document of model structural DBR for the design of Air Concourse and FOB for station redevelopment projects and circulating it to Zonal Railways for their comments. Accordingly, RLDA has prepared draft document of model structural DBR for the design of Air Concourse and FOB and the same is uploaded on RLDA's website at following address:

https://rlda.indianrailways.gov.in/view_section.jsp?lang=0&id=0,296,531,578

It is kindly requested that comments/ observations/ suggestions on the model document, if any, may be provided to RLDA for further necessary action.

15.10.24
Atul Kumar Verma
GM/ Design
email:gmdesign@rlda.railnet.gov.in

Copy: 1. PED/Gati Shakti/ Railway Board for kind information.
2. ED/SD & T/ Railway Board for kind information.
3. CE/SD/ All Zonal Railways for information and necessary action.

Model document for Structural Design Basis Report (DBR) for FOB and Air Concourse in the Station Redevelopment Projects

1.0 Purpose and Scope:

- Purpose of this document is to reduce time taken in the approval of Structural DBR and bringing uniformity in submissions of Structural DBR by the field units.
- This document is Outline of Structural Design Basis Report (DBR) proposed to be used as basis for DBR for the FOB and Air Concourse in station redevelopment projects.
- FOB which are of width more than 12m may be considered as Air concourse.
- Contents in this document are indicative. There may be some inclusions, omissions, changes, deviations, etc. in the contents of structural DBRs based on actual scope of work. While submitting DBR, such deviations should be clearly mentioned in forwarding letter to ease the examination.
- This document is meant to serve as a guide to the Designers and all stake holders but compliance with the provisions there-in does not relieve the structural designers/ proof check consultants in any way of their responsibility for the stability and soundness of the structure designed and compliance of structure to codal provisions and Contract Agreement.

2.0 Structural DBR should broadly contain following sections:

2.1 Part-1 of structural DBR should contain site conditions, site requirements, provisions of Contract Agreement, etc. which have implications on structural design. An indicative content of Part 1 of DBR is given at **Appendix A**. This part should be duly verified/ confirmed by Field unit before proceeding further for Part-2 of the DBR. This may be suitably modified as per project specific requirements and details, applicability of codes other than mentioned in it, different structural requirements, etc.

2.2 Based on the Part 1 of structural DBR, the consultant should carry out preliminary design to establish basic framing and structural design strategy. Site feasibility of structure including preliminary launching/ erection scheme should also be thought of at this stage. After finalizing the above-mentioned issues Part-2 of the DBR should be prepared.

2.3 Part-2 of structural DBR should be related to provisions of structural framing, codes and codal hierarchy, materials, loads, loads combinations, durability requirements, deflections considerations proposed to be used in the design of structure. An indicative content of Part 2

of DBR is given at **Appendix B**. This may be suitably modified as per project specific requirements, applicability of codes other than mentioned in it, different structural requirements, etc.

2.4 Once the detailed structural design is found broadly feasible, the noise and vibration studies should be taken up. Part 3 of structural DBR should be taken up at this stage.

2.5 Part-3 of structural DBR should be related to provisions of requirements for maintenance of structure and mitigation of noise and vibrations. An indicative content of Part 1 of DBR is given at **Appendix C**.

2.6 Structural DBR should also contain the following top sheet details and disclaimer:

2.6.1 Top sheet of DBR indicating name of project, DBR title, contractor's firm, consultant's firm, etc. It should also contain a specific DBR number, revisions done in this DBR since its original version along with dates of revisions, reason for revision in DBR. It should also contain names of author and checker of the document. DBR shall also include details of contents duly indicating chapters/ clauses number along with its heading details and page numbers and List of tables/ figures/ drawings/ pictures/ appendices duly indicating number of table/ figure/ drawing/ picture/ appendices along with its heading details and page numbers should be given in DBR

2.6.2 Disclaimer

"DBR is not a design document and is intended for use by all project stakeholders as a guide for planning and design principles followed during design of particular Railway Station (Name of the Station). At one Level, DBR contains a list of terms, conditions, project demands, performance goals, and legal and codal requirements. At another Level, it contains the thought processes, rationale and philosophy behind design decisions made to meet the project requirements.

This DBR is supposed to act as supplement to the requirements given in tender documents. Any provision in the DBR can at best explain or elaborate requirements from a project, but never replace or over-ride any provision in Contract Agreement."

2.7 Designer should be involved actively during the construction phase of the structures. The maintenance manual provisions identifying the critical components, their inspection frequency and maintenance instructions shall be given by the designer.

Designer should identify the critical components and joints of the structure which need to be designed for redundancy. Special attention should be given to monitoring and maintenance of such members / joints and these should also be suitably incorporated in the maintenance manual which should be prepared jointly by designer and field units and approved by competent authority.

2.8 DBR should have the provision for the structure to be amenable for de-launching in future, if required. Suitable de-launching scheme should be submitted during design stage itself. Designer should incorporate suitable arrangements such as jacking points, brackets, lifting points, etc. as per the proposed de-launching scheme in the structure. The designer should also submit the launching scheme jointly with the field unit along with the design document for approval by the competent authority.

Appendix A: Part 1 of Structural DBR

1.0 Brief description of the project and structures covered in DBR

1.1 This section should give brief description of the project with following details:

a. Location
b. Architectural intent
c. Location of different structures on plan
d. Typical cross sections of structures covered in DBR
e. Details of existing structures which are interacting with new structures
f. Floor wise usages including flexibility, if any
g. Future requirements, if any, including horizontal and vertical expansion.

1.2 Details of the structures proposed to be covered in the DBR should also be provided in this section.

1.3 Design life of structures being covered in DBR

Design life of various structures and components of structures, proposed to be covered in structural DBR should be provided in this section

2.0 Local factors affecting structural design

This section should give brief description of following local factors which affect structural design:

a. Seismic zone, soil type and other local factors having effect on seismic forces
b. Wind zone, escarpment effect and other local factors having effect on wind forces
c. Diurnal and annual temperature variations
d. Interaction of structure with tracks
e. Indian Railways Schedule of Dimensions (IRSOD) requirements or any other IR policy related to clearances
f. Soil conditions and other geo-technical factors having implication on foundation design
g. Liquefaction considerations
h. Water table and nearest water body
i. Rainfall data

3.0 Clearances

Necessary clearances as per IR Schedule of Dimensions (BG) of latest version or any other IR policy related to clearances should be ensured for various structures which are situated on platform/ in vicinity of tracks/ crossing the tracks. A diagram showing this should be incorporated in the DBR.

4.0 Soil Parameters, Design Ground Water Table and Liquefaction

This section should cover summary of important parameter related to geo-technical investigation and important design parameters related to soil having implication on the design of structure.

Location of ground water table should be decided based on the various site exploration and available data. This should be suitably included in DBR. Moreover, criterion for evaluation of various forces, effects and design dependent on it, should also be suitably incorporated in the DBR at respective places.

Evaluation of liquefaction potential of soil and its effect on the design of the structure should be suitably incorporated in this section.

Appendix B: Part 2 of Structural DBR

1.0 Type of structural framing chosen along with its rationale

1.1 This section should cover the structures which are in scope of the DBR along with salient features of each structure covered by DBR such as purpose of structure, its schematic layout, plan and elevation along with grid details.

1.2 This should also include basic structural framing details of structure along with the rationale for choosing the same. Basic structural framing details should also include the details related to foundation system adopted for the structure. Basic structural system should be described properly in this section with the help of neat and duly labelled explanatory schematic diagrams. Snapshots from structural analysis model should not be used for this purpose. An indicative description related to foundation system is given in **Annexure IV** and suitable description in DBR regarding foundation system as decided may be added accordingly.

2.0 Codes and Codal Hierarchy

2.1 Applicable relevant codes, standards, specifications, manuals, guidelines etc. should be mentioned in this section. These should be of latest revision including all amendments & corrections. **Relevant IR standard should be used while designing of structure crossing above or below railway tracks as per its applicability, if available. Otherwise, the codes as mentioned in codal hierarchy should be used as per its applicability for structure crossing above or below railway tracks.**

Reference may be taken of the list given in **Annexure I**. This list is indicative only and additional codes, standards, specifications, manuals, guidelines, etc. may be included in this list as per requirement of the project. Some codes prescribed in this list may not be required for specific project. The same may be deleted also while submitting DBR.

2.2 Order of preferences of codes shall be as follows:

i. IRS
ii. IS
iii. IRC
iv. BS or Euro Codes
v. AASHTO

vi. Any other international code with approval of Competent Authority

3.0 Material Specification

This section should cover the details and references of specifications for materials to be used in the construction of structure such as cement, concrete, prestressing steel for tendons, structural steel, reinforcement steel, etc. Details and references of specifications related to new/ innovative materials proposed to be used in construction should also be included in this section only. An indicative description related to this section is given in **Annexure II** for guidance and same should be modified as per type of structures, applicable codal references, etc.

4.0 Loads, Load cases and Load Combinations

This section should cover the details and references of various loads which may be applied on structure during its design life including construction of structure and required to be considered for design of structures. This section should also cover the references of load combinations required to be considered for design of structure. An indicative description related to this section is given in **Annexure III** for guidance and same should be modified as per type of structures, applicable codal references, etc. Loads and load combinations given in this section is indicative only and these should be provided in DBR as per various applicable loads and load combinations applicable for structures in scope of DBR. However, executing unit may specify additional loads in the DBR taking into account structure's specific requirements.

5.0 Structural Analysis and Design methodology

This section of DBR should cover the details/provisions related to codes proposed to be followed in the structural analysis and design of structures and its various components. An indicative description of the same is given in **Annexure V** for guidance and same should be modified as per type of structures, applicable codal references, etc. Any additional analysis and design description depending on the type of structure, site conditions, etc. may be added, if required.

6.0 Durability Requirements

This section should provide details and references for the various durability requirements to be considered in design such as concrete grades, reinforcement cover, fire resistance period,

crack width requirement, etc. based on the exposure condition of structure. An indicative description of the same is given in **Annexure VI** for guidance and same should be modified as per type of structures, applicable codal references, etc. Any additional durability requirements depending on the type of structure, site conditions, etc. may be added, if required.

7.0 Vertical Deflection and Lateral Sway and Drift

This section should provide details, requirements and references for the criterion to be met by structure related to deflection, sway, etc. An indicative description is given in **Annexure VII**, however it may be modified according to site conditions, structural requirements, applicable codes, etc., if required.

Appendix C: Part 3 of Structural DBR

1.0 Mitigation of Noise and Vibration

This section may contain following items related to noise and vibration mitigation:

- List of Codal references, specifications, guidelines, documents, etc. to be followed.
- Source and nature of noise and vibration such as trains/ nearby metros/ airports, etc.
- Results of the study of the effect of sources on the structure borne noise and vibrations
- Remedial measures in design/ construction, if required
- Expected final noise and vibration level after taking remedial measures

2.0 Requirements for maintenance of structure

This section should contain various facilities/ services/ attachments required to access the various parts of structure for inspection/ maintenance of structure. Strategies for water proofing, proper functioning of construction/ expansion joints, damp protection, corrosion protection, cleaning, repainting, drainage, routine repairs/ replacements, etc. should also be included in this section.

Further, this section should have an annexure showing design life assumed by designer for different components such as seals, bearings, expansion joints, coatings, etc. and its expected maintenance.

3.0 List of critical components and joints of the structure should be documented by the designer. Special attention should be given to monitoring and maintenance of such members and joints and these should be suitably incorporated in the maintenance manual which should be prepared jointly by designer and field units and approved by competent authority.

Annexure I

The structure and foundations shall be designed using the list of the relevant codes and standards are given below:

• IS 875 (Part 1): 1987 - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures- Unit Weights of Building Materials and Stored Materials

• IS 875 (Part 2): 1987 - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures-Imposed Loads

• IS 875 (Part 3): 2015 - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures-Wind Loads

• IS 875 (Part 5): 1987- Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures-Special Loads and Load Combinations

• IS 1893 (Part 1): 2016- Indian Standard Criteria for Earthquake Resistant Design of Structures

• IS 432 (Part 1): 1982 – Specification of mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement – Mild steel and Medium Tensile Steel Bars

• IS 432 (Part 2): 1982 – Specification of Mild Steel and Medium Tensile Steel bars and Hard drawn Steel Wire for concrete reinforcement – Hard drawn Steel Wire

• IS 4326: 2013 - Code of Practice for Earthquake Resistant Design and Construction of Buildings

• IS 13920: 2016 - Ductile Design and Detailing of Reinforced Concrete structures subjected to lateral forces

• IS 18168: 2023- Earthquake resistant design and detailing of steel buildings- Code of practice

• IS 456: 2000 - Code of Practice for plain and reinforced concrete

• IS 1786: 2008 - Specification for high strength deformed steel bars and wires for concrete reinforcement

• IS 800: 2007 - Code for practice for general construction in steel

• NBC 2016 - The National Building code of India, 2016

• IS 2911: 2010 – Code of Practice for Design and Construction of Pile Foundations

• IS 1892: 1979 – Code of Practice for subsurface investigation for foundations (first revision)

• IS 1343: 2012 – Prestressed concrete – code of practice (second revision)

• IS 1498: 1970 - Classification and identification of soils for general engineering purposes

• IS 1904: 1986 - Code of practice for design and construction of foundations in soils: General requirements

• IS 1080: 1985 - Code of Practice for Design and Construction Of Shallow Foundations In Soils (Other Than Raft, Ring And Shell)

• IS 2950(Part 1): 1981 - Code for practice for design & construction of Raft foundation

• IS 3370 (Part 1): 2021 - Code of practice for concrete structure for storage of liquids – Reinforced concrete structures

• IS 814:2004 - Covered electrodes for manual metal arc welding of carbon and carbon manganese steel – specification (sixth revision)

• IS 1367:2002 - Technical supply conditions for threaded steel fasteners

• IS:1785-part1 - Specification for plain hard-drawn steel wire for prestressed concrete, part 1 – cold drawn stress-relieved wire, second revision)

• IS 2062:2011 - Hot rolled medium and high tensile structural steel – specification (seventh revision)

• IS 14593:1988 - Design and construction of bored cast-in-situ piles founded on rocks-Guidelines

• IS 16700: 2017 – Criteria for Structural Safety of Tall Concrete Buildings

• IS 8009 (Part 1): 1976 – Code of Practice for calculation of settlement of foundations

• IS 10262: 2009 – Code of Practice for Design and Construction of Raft Foundations

• IS 1642: 1989 – Indian Standard Code of Practice for Fire Safety of Buildings (General): Details of Construction

• IS 3414: 1968 – Code of Practice for design and installation of joints in buildings

• IS 10297: 1982 – Code of Practice for design and construction of floors and roofs using precast reinforced/ prestressed concrete

• IS 3935: 1966- Code of practice for composite construction

• IS 11384: 1985- Code of Practice for Composite Construction in Structural Steel and Concrete

• SP 16 - Design Aids for Reinforced Concrete

• SP 34 - Handbook on Concrete reinforcement & Detailing

• SP 6 – Handbook for structural engineers – steel

- IRC 6: 2017 – Standard specifications and code of practice for road bridges
- IRC 112: 2020 – Code of practice for concrete road bridges
- IRC SP 56: 2011- Guidelines for steel pedestrian bridges
- IRS Bridge Rules Adopted 1941 Revision 1964 Reprint 2014
- IRS Steel Bridge Code Adopted 1941 Revision 1962 Reprint 2017
- IR Schedule of Dimensions (BG) Revision 2022
- IRS Concrete Bridge Code Adopted 1936 Revision 1997 Reprint 2014
- IRS B1 Fabrication Specification Adopted 1934 Revision 2001 Reprint 2008
- IRS Welded Bridge Code Adopted 1972 Revision 2001
- IRS Seismic Code Adopted 2017 Revision 2020
- IR Bridge Manual 1998
- IRS Bridge Sub-Structure and Foundation Code Adopted 1936 Revision 2013
- RDSO CT-38: 2015 Guidelines for noise and vibrations

Annexure II

Material Specification

1.0 Cement, Aggregates, Water and Admixtures

For plain and reinforced concrete structures cement shall be used as per clause 5.1 of IS: 456. For PSC structures Cl. 5.1 of IS: 1343 shall be used.

Aggregates shall be as per clause 5.3 of IS: 456 for plain and reinforced concrete structures and as per clause 5.3 of IS: 1343 for PSC structures.

Water shall be as per clause 5.4 of IS: 456 for plain and reinforced concrete structures and as per clause 5.4 of IS: 1343 for PSC structures.

Admixtures shall be as per clause 5.5 of IS: 456 for plain and reinforced concrete structures and as per clause 5.5 of IS: 1343 for PSC structures.

2.0 Concrete

2.1 It should be as per Cl. 6, 7, 8, 9, 10, 13, 14, 15, 16 and 17 of IS: 456 in case of Plain and Reinforced Concrete structures and Clause 6, 7, 8, 9, 10, 14, 15, 16, 17 and 18 of IS: 1343 for Pre-stressed concrete structures.

Short term modulus of elasticity (Ec) shall be taken as per Cl. 6.2.3.1 of IS: 456 for Plain and Reinforced Concrete structures and IS: 1343 for Pre-stressed concrete structures.

The modular ratio for concrete grades shall be taken as per Annex B of IS: 456. Modular ratio for steel concrete composite shall be taken as per clause 9.3 of IS: 11384.

2.2 Various components to be used in making concrete such as coarse aggregate, fine aggregate, waters, admixtures, etc. should be as per relevant IS Codes. Quality Assurance Program (QAP) for concrete to get desired quality and grade of concrete, should be prepared and got approved from competent authority before execution of work. QAP of concrete should indicate various raw materials for concrete and various processes involved from initial mixing, placing, vibrating, curing, etc. This should also include various tests done for raw materials for concrete and acceptance criterion for it apart from tests and acceptance criterion for concrete.

3.0 Prestressing steel for tendons

It should be as per Cl. 5.6.1 of IS: 1343. Young's Modulus should be as per Cl. 5.6 of IS: 1343. Prestressing Units to be as per Cl. 13 of IS: 1343. Maximum initial Prestress should be as per Cl. 19.5.1 of IS: 1343. Sheathing should be as per Cl. 12.2 of IS: 1343. QAP for prestressing concrete should also be prepared and got approved from competent authority on same lines as mentioned in para 2.2 above.

4.0 Structural Steel

4.1 Structural steel used shall confirm to following:

a) Hollow steel sections as per IS: 4923

b) Steel for general Structural Purpose as per IS: 2062

c) Steel tubes for structural purpose as per IS: 1161

4.2 Following properties of structural steel shall be considered:

- Young's Modulus of steel shall be taken as 20,000kg/mm^2 as per Clause 2.2.4 of IS: 800
- Density: 7850 kg/m^3 as per clause 2.2.4 of IS: 800
- Poisson's Ratio: 0.30 as per clause 2.2.4 of IS: 800
- Thermal Expansion Coefficient: 12x10^{-6} as per clause 2.2.4 of IS: 800

4.3 Fabrication shall be done in accordance with IRS-B1. Welding shall be done as per relevant IS codes for welding. Weldability of steel and use of electrodes to be mentioned in DBR. Quality Assurance Program (QAP) for fabrication of structural steel duly indicating raw materials and checks for it, processes involved in steel fabrication and acceptance criterion for fabricated structural steel, etc. should be prepared and got approved from competent authority before execution of work. Welding Procedure Specification Sheet (WPSS) and Welding Procedure Qualification Record (WPQR) should also be prepared and got approved from competent authority.

5.0 Reinforcement Steel (Rebars)

5.1 Reinforcement shall be as per clause 5.6 of IS:456 for Plain and Reinforced concrete structures and as per clause 5.6.2 of IS:1343 for pre-stressed concrete structures.

5.2 For Seismic zone III, IV & V HYSD steel bars having minimum elongation of 14.5 percent and conforming to requirements of IS:1786 shall be used

5.3 Stainless Steel rebars shall be used in up to 30 Km from coastal areas and in extreme cases as per clause 7.1.5 (b) of IRS Concrete Bridge Code.

5.4 All reinforcement shall be detailed in accordance with Cl. 12 & 26 of IS: 456 & SP: 34 for plain and reinforced concrete structures and as per Cl. 12.3 & 19.6.3 of IS: 1343 for PSC structures. The ductile detailing of seismic resisting RC elements shall comply with requirements of IS: 13920.

6.0 Storage of material at site shall be done in accordance with IS: 4082.

Annexure III

Loads, Load Cases and Load Combinations

1.0 Load

Characteristic loads shall be determined from the various parts of IS 875, IRS Bridge Rule, IRS Seismic Code, etc., as applicable, in Air Concourse and FOB using the provisions given below:

1.1 Dead Load (DL)

The dead load of structure is primarily the self-weight of structural members which is calculated based on known unit weight of the materials in accordance with IS 875 Part 1. Dead load shall be based on the actual cross-sectional area and unit weights of materials and shall include the weight of structural members of the structure and permanent in nature. In addition to above, a self-weight multiplier of 1.10 will be employed for structural steel components of structure to account for the weight of connection plates, angles, bolts and welds.

1.2 Super Imposed Dead Load (SIDL)

SIDL to be calculated as per the finishes, services, partitions and other relevant architectural and MEPF details. This should include weight of materials on the structure that are not structural elements but are permanent in nature. IS 875 Part 1 or actual details provided by manufacture may be used for the calculation of SIDL.

1.3 Live Load (LL)

Live load on Air Concourse and FOB including ramps and staircase should be taken from clause 2.3.2.1 of IRS Bridge Rule. For other associated structures such as through roof it should be decided as per IS 875 (Part 2).

If the value of design Live load is required to be raised for future requirements in Air Concourse/FOB then it shall be specifically mentioned.

1.4 Earthquake Loads (EQ)

Earthquake loads shall follow the provisions of IRS Seismic Code. In case of non-availability of any provision in IRS Seismic Code reference of IS 1893 (Part 1) may be taken. Some of salient provisions related to Seismic loading are given below:

1.4.1 Seismic Zone and Zone Factor (Z)

It should be decided as per clause 9.4.6 of IRS Seismic Code based on the location of project.

1.4.2 Importance Factor (I)

It should be taken as 1.5 for FOB, Air Concourse and structures associated with it.

1.4.3 Response Reduction Factor (R)

It should be decided as per clause 9.4.5 of IRS Seismic Code for different components of structure i.e. Superstructure, Substructure, Foundation, etc.

1.4.4 Design Acceleration Spectrum (Sa/g)

Depending upon the type of soil and for particular natural period of structure, Sa/g should be calculated on the basis of Cl. 9.4.3 of IRS Seismic Code.

1.4.5 The horizontal seismic design coefficient (A_h) should be calculated on the basis of Cl. 9.4.1 of IRS Seismic Code and

Vertical seismic design coefficient (A_v) should be calculated on the basis of Cl. 9.4.2 of IRS Seismic Code.

1.4.6 Effects of design earthquake forces applied on structure may be considered using stipulations of Cl. 9.1 of IRS Seismic Code.

1.4.7 Detailing should be as per IS: 13920 for RCC structures, Section 12 of IS 800 and IS 18168 for Steel structures, IS: 4326 for other structures. The provision of ductile design for building frames shall be adopted from IS 1893 (Part-1).

1.5 Wind Loads (WL)

Wind loads on FOB to be considered as per provisions of IRS Bridge Rules. For Air Concourse, Through roof, etc. Wind Loads (longitudinal & transverse) shall be calculated as stated in IS 875: Part 3. Some of its salient provisions are given below:

1.5.1 Design wind speed V_z should be calculated as per stipulations of Cl. 6.3 of IS 875: Part 3.

- Basic Wind Speed V_b to be taken as per Cl. 6.2 of IS 875: Part 3.
- K_1 (Risk Coefficient) to be decided as per stipulations of Cl. 6.3.1 of IS 875: Part 3 on the basis of class of structure.
- K_2 (Terrain and Height Factor) to be decided as per stipulations of Cl. 6.3.2 of IS 875: Part 3 on the basis of type of terrain and height of structure.
- K_3 (Topography factor) to be decided as per stipulations of Cl. 6.3.3 of IS 875: Part 3

- K_4 (Importance Factor for cyclonic region) to be decided as per stipulations of Cl. 6.3.4 of IS 875: Part 3

1.5.2 Design wind pressure to be calculated as per stipulations of Cl 7.2 of IS 875: Part 3

1.5.3 Wind load on individual members and structure as a whole should be estimated using Cl 7.3 and 7.4 of IS 875: Part 3 respectively. Interference effects, Dynamic effects, etc. should be taken care of as applicable as per site conditions.

1.6 Construction and Erection Loads (ER)

The weight of all temporary and permanent materials together with all other forces and effects which can operate on any part of structure during construction/erection shall be taken into account. Allowances shall be made in the permanent design for any locked in stresses caused in any member during erection.

1.7 Temperature Load (TL)

As per Cl. 19.5 of IS: 456. Temperature gradient shall be considered as per CL. 215 of IRC-6, if applicable.

1.8 Shrinkage

Shrinkage strain shall be evaluated as Cl. 6.2.4 of IS: 456 for plain and RCC structures and Cl. 6.2.4 of IS: 1343 for prestressed concrete structures.

1.9 Creep

Creep strain shall be evaluated as Cl. 6.2.5 of IS: 456 for plain and RCC structures and Cl. 6.2.5 of IS: 1343 for prestressed concrete structures.

1.10 Earth Pressure (EP) & Water pressure (WP)

In the design of structures or part of structures below ground level, the pressure exerted by soil or water or both shall be duly accounted for. When a portion or whole of the soil is below the free water surface, the lateral earth pressure shall be evaluated for weight of soil diminished by buoyancy and the full hydrostatic pressure. (As per IS: 875-part 5).

All foundation slabs / footings subjected to water pressure shall be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure. Checking of overturning of foundation under submerged condition shall be done considering buoyant weight of foundation.

1.11 Surcharge Load (SL)

In the design of structures or the parts of the structures below ground level, such as foundation, retaining walls, etc. the pressure exerted by surcharge from stationary or moving load (Train loading as per IRS Bridge Rule or Road Vehicle as per IRC, if any), shall be duly accounted for.

1.12 Prestressing force (PS)

The prestressing force should be as per IS: 1343.

1.13 Settlement (DS)

Maximum and differential settlement shall not exceed, as provided in Table 1 of IS: 1904 for isolated and raft foundations and as per IS 2911-part 4 for pile foundations.

1.14 Loads on parapets

The pedestrian parapets are designed as Type 1 according to IRC:6 Cl. 206.5 (solid/partially filled parapets continuously cantilevering along full length of deck).

1.15 Forces due to accidental impact of any vehicle

Cl 2.16 of IRS Bridge Rules should be used for evaluation of Forces due to accidental impact of any vehicle

1.16 Other Forces and Effects

As per Cl. 19.6 of IS: 456.

2.0 Each component of the structure shall be designed and checked for all possible combinations of applied loads and forces. They shall resist effect of the worst combination. Load combination for construction load case shall be considered as per methodology of construction

3.0 Load Combinations

3.1 FOB:

- For PSC structure, the load combinations shall be as per Section 4 and table 7 of IS: 1343.
- For steel structures, the load combinations shall be as per IRS Steel Bridge Code.

- For RCC structures, the load combinations shall be as per Section 5 and Table 18 of IS: 456.
- For Steel Concrete composite structures, the load combinations shall be as per Section 7 and Table 6 of IS: 11384 or IRS Steel Bridge Code.

3.2 Air Concourse and Through roof:

- For PSC structure, the load combinations shall be as per Section 4 and table 7 of IS: 1343.
- For Steel structures, the load combinations shall be as per Section 5 and Table 4 of IS: 800.
- For RCC structures, the load combinations shall be as per Section 5 and Table 18 of IS: 456.
- For Steel Concrete composite structures, the load combinations shall be as per Section 7 and Table 6 of IS: 11384.

Annexure IV

Foundation System

1.0 Type of foundation

- Considering the nature of ground, type of proposed structure, expected loads on foundation, the following type of foundations are considered practical:
  a. Spread or pad footing
  b. Raft Foundation
  c. Pile foundation
- No matter the type of foundation to be adopted, the following performance criteria shall be satisfied:
  a. Foundation must not fail in shear
  b. Foundation must not settle by more than the settlements permitted as per table-1 of IS: 1904 for isolated and raft foundations and as per IS 2911-part 4 for pile foundations.

2.0 Design of Pile Foundation

IS: 2911 shall be followed for design of pile, load capacity etc. Theoretical estimation of settlement for deep foundation shall be done in accordance with IS: 8009-Part-2.

3.0 Open foundation

Open foundation shall be designed as per IS: 456, IS: 1904, IS: 6403. Calculation of settlements shall be done as per IS: 8009-Part-1.

Annexure V

Structural Analysis and Design Methodology

1.0 Structural analysis and design considerations of FOB shall be as per:

- Section 3 and 4 of IS: 1343 For PSC structure.
- IRS Steel Bridge Code for steel structures.
- Section 3 to 5 of IS: 456 for RCC structures.
- Cl. 6 to 13 of IS: 11384 for Steel Concrete composite structures or IRS Steel Bridge Code.

2.0 Structural analysis and design considerations of Air Concourse and Through Roof shall be as per:

- Section 3 and 4 of IS: 1343 For PSC structure.
- Section 3 to 10 of IS: 800 for steel structures.
- Section 3 to 5 of IS: 456 for RCC structures.
- Cl. 6 to 13 of IS: 11384 for Steel Concrete composite structures.

Annexure VI

Durability Requirements

1.0 Durability of concrete shall be as per Cl. 8 of IS: 456 for Plain & RCC, as per Cl. 8 of IS: 1343 for PSC elements and as per section 15 of IS: 800 for steel structures.

2.0 Exposure condition of structure should be decided as per the relevant clauses and should be mentioned in DBR. Various parameters determining durability of structure should be decided based on the exposure condition of various structures in scope of DBR. Here it is pertinent to mention that various part of a structure may be subjected to different environment condition e.g. exposure condition of substructure/ foundation may be different from superstructure depending on the aggressiveness of soil. Hence exposure condition for structures and its various components should be specified in DBR accordingly.

3.0 Concrete Grades

The minimum grade of concrete shall be as per IS: 456 for Plain and RCC structures and IS: 1343 for PSC structures. Minimum grade of concrete for binding layers and levelling course shall also be indicated.

4.0 Cover to Reinforcement

As per Cl. 26.4 of IS: 456 for Plain and RCC structures and Cl. 12.3.2 of IS: 1343 for PSC structures. Cover to Prestressing steel shall be in accordance with Cl. 12.1.6 of IS: 1343. For the Pile foundations, cover shall be taken as 75mm for all exposure conditions.

5.0 Fire Resistance

Fire resistance period should be as per architectural DBR, other relevant codes and local bye laws in this regard. However, in any case it should not be less than 2 hours. Fire resistance and fire design should be done as per Cl. 21 of IS: 456 for concrete structures, as per section 16 of IS: 800 for steel structures and as per Cl. 15 of IS: 11384 for composite structure.

6.0 Crack width Check

All structural concrete elements shall be designed to prevent excessive cracking due to flexure, early age thermal and shrinkage. Flexural crack width shall be checked in accordance

with Cl. 35.3.2 and 43 of IS: 456 for Plain and RCC structures and Cl. 20.3.2 & 24.2 of IS: 1343 for PSC structures.

Annexure VII

Vertical Deflection and Lateral Sway

1.0 Vertical Deflection

1.1 For Steel and Steel-Concrete Composite structures, vertical deflections of the deck beams should be limited to L/325 as specified in the Cl. 4.17 (ii) of IRS Steel Bridge Code. Pre-camber may be provided as specified in Cl. 4.16.4 of IRS Steel Bridge Code.

1.2 For Steel and Steel-Concrete Composite structures, limits for vertical deflections for elements which support material susceptible to cracking should be as per Cl. 5.6.1 of IS 800.

1.3 For PCC and RCC Structures, it should be limited as per Cl. 23.2 of IS: 456.

1.4 For PSC structures deflections, it should be limited as per Cl. 20.3.1 if IS: 1343.

2.0 Lateral Sway

2.1 For Steel and Steel-Concrete Composite structures, it should be limited as per Cl. 5.6.1 of IS 800.

2.2 For PCC and RCC Structures, it should be limited as per Cl 20.5 of IS 456.

Annexure VIII

Vibration Analysis

1.0 Floor Vibration (Walking/Running)

- For Air Concourse Floor vibration shall be studied as per IS:800 and IS 456
- For FOB Floor Vibration shall be studied as per IRC: SP:56: 2011 and IS:800.

2.0 Vibrations due to train movement

Vibration due to movement of trains to be checked and kept in accordance with the relevant sections of design national/international codes and relevant literature may be referred. RDSO report no. CT-38 may also be referred for the same.

********** **End of Document** **********