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RCC FOOT OVER BRIDGE ANALYSIS AND COMPARISON WITH STEEL FOOT OVER BRIDGE

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Abstract
The Bridge is a structure that provides a passage over a gap or obstacle like a roadway, tunnel, river, etc. Construction of bridges is always challenging for the civil engineer. The different types of bridges play a different role according to their types and material. The pedestrian bridge is one of the popular bridges which is used to eliminate the delay and congestion in traffic on the highway. Similarly, the foot over bridge is used to eliminate the conflicts between vehicles or railway. The foot over the bridge can be made of any combination of material namely concrete, steel or composites. Now-days it is observed that use steel foot over bridges is more because it gives safe, efficient and economical results with speedy construction. The objective of this paper is to present the detailed concept and working principle of various configurations of the foot over bridges and the current trends in implementation of the foot over the bridge for pedestrian or cyclist. In addition to these various problems associated with the foot over the bridge are also discussed. A detailed investigation of literature available in the field of the foot over bridges carried out and the summary and gaps encountered in the study are listed in this paper.

Keywords - foot over bridge, steel materials, timber, truss types.

Introduction
The bridge is a structure that provides passage over obstacles such as valleys, rough terrain by crossing those obstacles with artificial materials. They first began being used in ancient times when first modern civilizations started rising in Mesopotamia. From that point on, knowledge, engineering, and manufacture of new bridge-building materials spread beyond their borders, enabling slow but steady adoption of bridges all across the world.
A foot over bridge is a bridge designed for the pedestrian. The bridge is a structure that links "two distinct areas at a height above the earth". The easy type of bridge is steppingstones, so this may have been one of the premature types of a footbridge. Foot over bridges are used to change platform at a railway station, skywalk in metro cities. Different types of design foot over bridges include timber foot over bridges, steel foot over bridges, and concrete foot over bridges. The steel truss is generally used for the construction of foot over bridges of different sizes. It is a useful material that provides provable solutions. Steel has long been recognized as the economic option for a range of foot over bridges. Steel foot over bridges are used because easy to assemble, less cost, low maintenance, flexibility in design.

Classification of Bridges
By design
(i) Beam bridges: It is the simplest structural forms for bridge spans supported by an abutment or pier at each end[1].No moments are transferred throughout the support, hence their structural type is known as simply supported. The simplest beam bridge could be a log (see log bridge), a wood plank, or a stone slab (see clapper bridge) laid across a stream. Bridges designed for

modern infrastructure will usually be constructed of steel or reinforced concrete, or a combination of both. The concrete elements may be reinforced, pre-stressed or post-tensioned. Such modern bridges include girder, plate girder, and box girder bridges, all types of beam bridges.
(ii)Truss: A truss is an assembly of members such as beams, connected by nodes, that creates a rigid structure.
By material
(i)Steel Bridges: Steel bridge may use a wide variety structural steel components and systems: girders, frames, trusses, arches, and susp5ension cables.
(ii)Concrete Bridges: There are two primary types of concrete bridges: reinforced and pre stressed.
(iii)Timber Bridges: Wooden bridges are used when the span is relatively short.

III. Objective of This Research Work

Before To analyze and design the structural behavior RCC-beam bridge and Steel under standards of congress. To study the IRC loading with congestion factor.
To analyses and design a Pedestrian Bridge over highways road in a metropolitan city.
To design a RCC structure with maximum strength, durability and safety factor.
To make use of a simple and effective design methodology and construction. The design procedure and methodology adopted is to be in conformance to the present methodology being used in the industry.
To analyze the structure using ETABS for the various loads acting on the structure.
To meet all the requirements of the codal provisions given in the codes, being considered and try to adopt economical sections in the structure.
To estimate and compression of the RCC bridge and Steel Bridge of their factor.

IV. Literature Review

In this section, the present theories and practices related to the behavior of foot over the bridge are studied by referring to published literature in various journals, books and conferences from India and abroad. Following a review of Literature gives an outlook on the behavior of foot over bridge.

V.Chandrikka et al. (2019)
Have investigated the performance of the Analysis and design of cold-formed steel foot over bridge at kondalampaaty bye-pass, salem. The main purpose of this paper is to design a harmless, economical and simple to assemble foot over bridges for walkers. In this paper analysis of cold-formed steel box section using STAAD Pro. Software. The thickness of the steel sheet is 2 to 3 mm and yield strength of the steel sheet is 280 $N/mm2$. The cold-formed steel box section of the foot over bridge is constructed because of bending operation simple and low cost. Design of cold-formed steel box-section columns and beams are used EUROCODES EN 1993 and done manually. The authors conclude that the cold-formed box section will reduce the dead weight of the structure and provides high strength and durability.

M. Limje et al. (2019)
Examined the detailed Appraisal and Design of Foot over Bridge. The main purpose of this paper is to analysis and design of foot over the bridge between the stretch surat railway station and surat bus station with high hourly volume traffic. In this paper analysis of foot over bridge using STAAD Pro. In this paper Foot over bridges specially design for pedestrians and cyclists. The total length of the foot over bridge is 171m and the height of the foot over bridge is 12m and the width of the foot over bridge is 4m. The design of foot over the bridge has done by using IS 800:2007. The main purpose of this paper is to design economical and provided economical sections. The foot over bridges design considering future changes and loading.

B. Herbudiman (March 2017)
Has carried out their research work on the Design of pedestrian truss bridge with Sengon-Rubber laminated veneer lumber.The wood material is used to make light vehicles or foot over bridges. Timber type bridges design for a medium span of the bridge. The applications of this type of bridge are low cost, lightweight and have aesthetic value. Timber supply decreases so its alternative laminated veneer lumber consists of thin layers that glued together with sengon wood (density of 0.35 kg/m3) and rubberwood (density of 0.61 kg/m3) as base materials. The design of timber foot over bridge consists of pedestrian and light vehicle. Structural analysis using SAP2000. In this paper, the Response spectrum method is used. The main benefit of this research is to make laminated veneer lumber as an alternative material for foot over bridge.

A. Kulkarni et al. (2015)
Has a study on material properties for the foot over bridges to improve the durability and strength. Last three decades various types of good quality materials are introduces in the market. It is proven that good quality material increases the strength of the bridge. For this article prime focus is to provide good quality of material and cost-efficient bridge structure with no compromise with main structural properties. The author considers two types of bridges such as steel foot over and cable foot over for the case study. For the analysis of these two bridges, STADD pro software is used. The design loads are taken as per IS 800:2007 code and all loads conditions are safely carried by the bridges but by comparison of the design . and drawing it is concluded that the cable foot over bridge is more durable and economical as compare to steel foot over bridge.
E.Rahul and kaushik Kumar (10-2014)
Has made efforts to design and optimize portable foot bridge which provide a solution that will aid a person carrying a load in crossing stream. The main motto was to minimize the total deformation of the structural member by optimizing the cross sections, materials properties and weight.

V. **Methodology**
The chapter describes the procedure that was used for designing three bridge alternatives, as well as the criterion that were used to select a fourth option of a pre-fabricated bridge. All calculations and designed can be found in this chapter. The AISC Load and Resistance Factor Design (LRFD) approach was used to design the members, components and connections for each bridge. The LRFD approach was used instead of the AISC Allowable Stress Design (ASD) approach because it is the more widely used method. The different loading combination were used for investigated to determine critical loading conditions for the members and components of each bridge. These loading combinations represent potential critical conditions that may realistically exist.
For the analysis of the bridge we used ETABS software and for push over analysis we used PEER data. In this analysis we used IS456-2000, IS856.

VI. Load Combination
Structures, components, and foundation shall be designed so that their design strength equal are exceed the effect of the factored load in the following load combination as per IS code-456-2000
- **1.5DL+1.5LL**
- **1.2(DL+LL+EQX)**
- **1.2(DL+LL-EQX)**
- **1.2(DL+LL+EQy)**
- **1.2(DL+LL-EQy)**
- **1.5(DL+EQx)**
- **1.5(Dl-EQx)**
- **1.5(DL+EQy)**

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- **1.5(DL-EQy)**
- **Study of different Zones:-** For the analysis of the building, we have taken Seismic Zone V.
- The terrain Category second and Soil is medium, with wind Speed of 45Km/h along X direction (00and 1800) and along Y direction (900 and 2700).

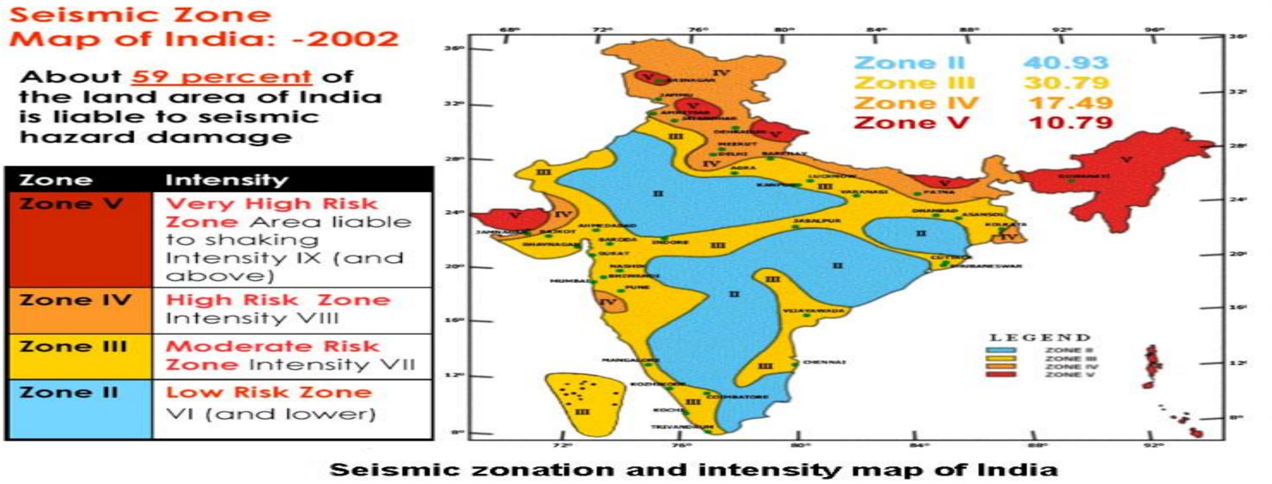
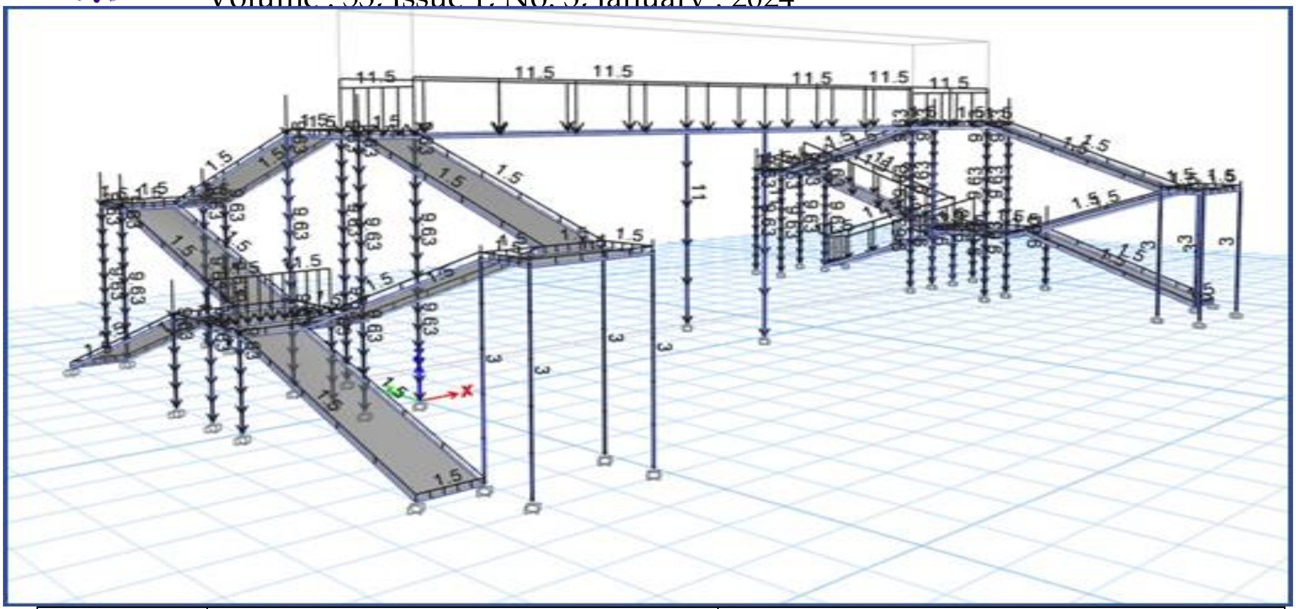


Figure 01: Seismic Zone of India

VII. Modelling of Foot over bridge

The strength and the stiffness of infill walls in a RC-Frame building should be considered. Infill walls act as a compressive member within a frame. Non-integrated infill walls act as a diagonal strut when subjected to lateral loads. Therefore an infill wall can be modeled as a diagonal strut in compression only.

Sr. No	Parameters	Dimensions/Type For RCC Foot Over Bridge
1	Plane dimensions	25X3
2	Angle of stair	12
3	Total height of building	30.5
4	Height of bridge	3
5	Size of beams	350X500mm
6	Size of columns	500X500mm 700X700mm
7	Thickness of slab	125mm
8	Frame Type	OMRF
9	Seismic Zone	4^{th}
10	Soil condition	Medium
11	Importance	1
12	Response Reduction	5
13	Damping Ratio of structure	0.05
14	Live load On floor	3KN
15	Wind Speed	45kmh
16	Windward Coff.-X	0.80
17	Windward Coff.-Y	0.86
18	Leeward Coff-X&Y	0.5
19	Terrain Category	2
20	Floor Finishing	15cm



21	Material	M35
22	Unit weights	Concrete-25KN Masonary-20KN

Table01: Parameters of RCC bridge

Viii. Images of ETABs Models:

Figure 02:3D Dead Load Of RCC Bridge Shell

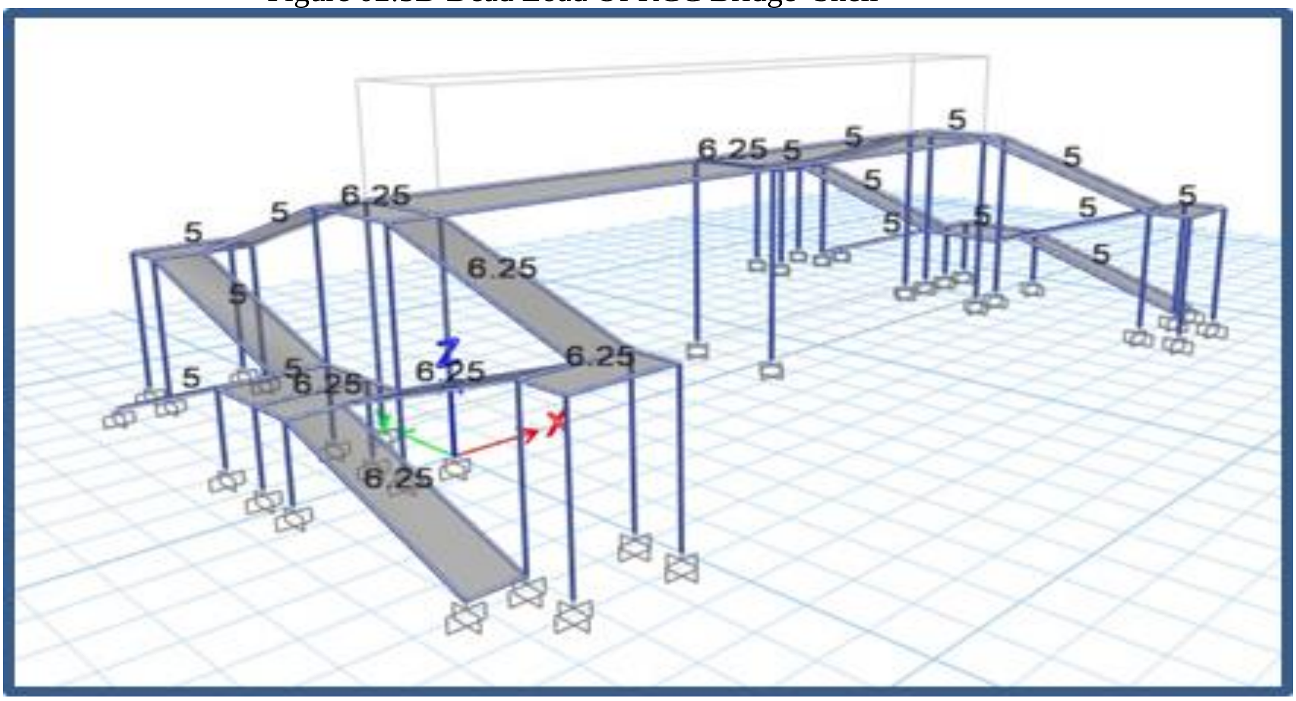


Figure 03: 3D Dead Load Of frame.

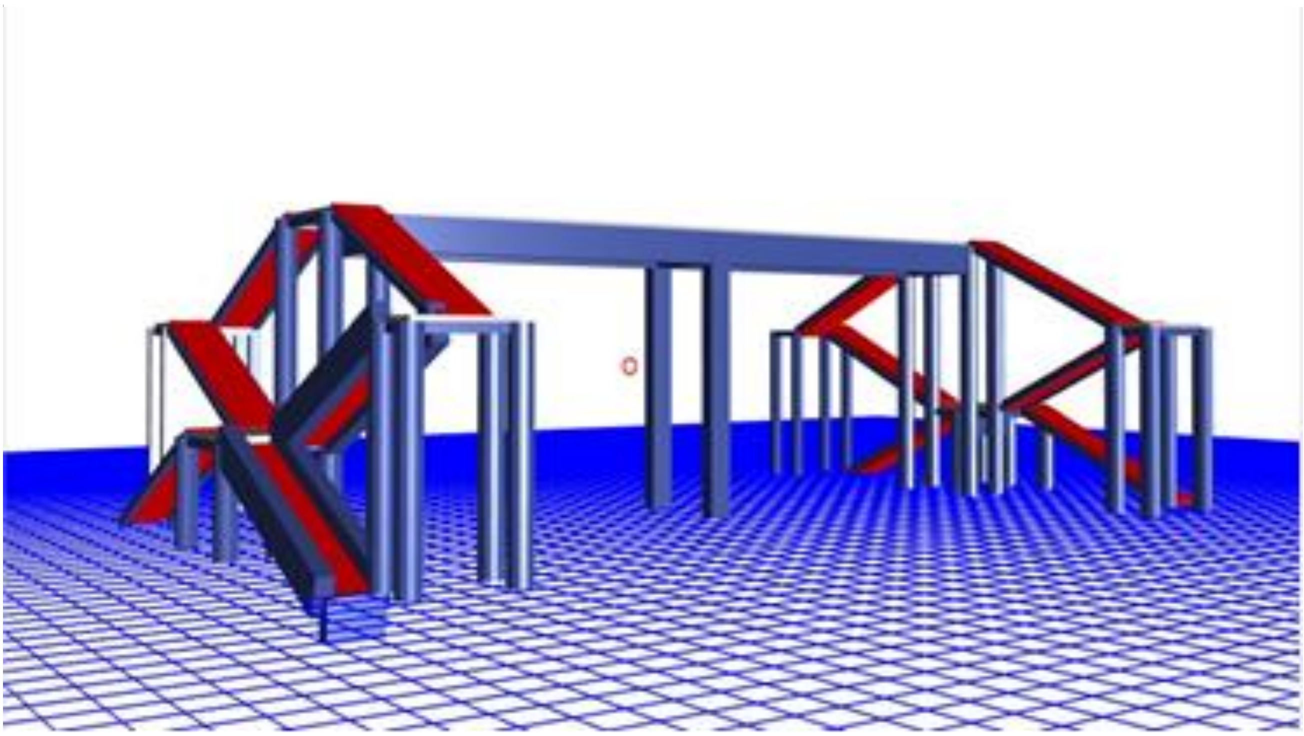


Figure04: 3D Image Of RCC Bridge.

IX. Results and Analysis

(I).Results

BASE REACTION TABLE

Output case	FX	FY	FZ	MX	MY	MZ
	kN	Kn	kN	kN-m	kN-m	kN-m
Dead	0	0	8731.6988	2350 1.8408	-115003. 636	0
Live	0	0	1086.4163	1452. 7913	-12181. 1838	0
Model	23.9208	-0.4251	0	3.5263	185.6 733	-51.5421
Model	- 258.6262	33.5466	0	74.75 65	-510.6 197	1117.5757
EQ-X	- 210.8401	0	0	0	-1512.7533	384.3772
EQ-Y	0	210.8401	0	5112.7533	0	- 2548.3984
Super dead load	0	0	339.5624	482.1249	-3894.7748	0
Dcon 15	0	0	12189.213	32339.4123	-157295.5135	461.2527
Dcon15	- 253.0081	- 253.0081	12189.213	30524.1083	-159110.8174	3058.0781
Dcon 16	253.0081	253.0081	12189.213	30524.1083	-155480.2095	- 3058.0781
Dcon 16	0	0	12189.213	28708.8044	-157295.5135	-461.2527

Dcon17	0	0	12189.213	32339.4123	-157295.5135	461.2527
Dcon17	-253.0081	-253.0081	12189.213	30524.1083	-159110.8174	-3058.0781
Dcon18	253.0081	253.0081	12189.213	30524.1083	-155480.2095	3058.0781
Dcon18	0	0	12189.213	28708.8044	-157295.5135	-461.2527
Dcon19	0	0	13606.8918	38245.0784	-178347.6162	576.5659
Dcon19	-316.2601	-316.2601	13606.8918	35975.9484	-180616.7461	-3822.5976
Dcon20	316.2601	316.2601	13606.8918	35975.9484	-176078.4862	3822.5976
Dcon20	0	0	13606.8918	33706.8185	-178347.6162	-576.5659
Dcon21	0	0	13606.8918	38245.0784	-178347.6162	576.5659
Dcon21	-316.2601	316.2601	13606.8918	35975.9484	-180616.7461	-3822.5976
Dcon22	316.2601	316.2601	8164.1351	35975.9484	-176078.4862	3822.5976
Dcon22	0	0	8164.1351	33706.8185	-178347.6162	-576.5659
Dcon23	0	0	8164.1351	23854.699	-107008.5697	576.5659
Dcon23	-316.2601	-316.2601	8164.1351	21585.5691	-109277.6997	-3822.5976
Dcon24	316.2601	316.2601	8164.1351	21585.5691	-104739.4398	3822.5976

Table 02:Base reaction table

Maximum Drift

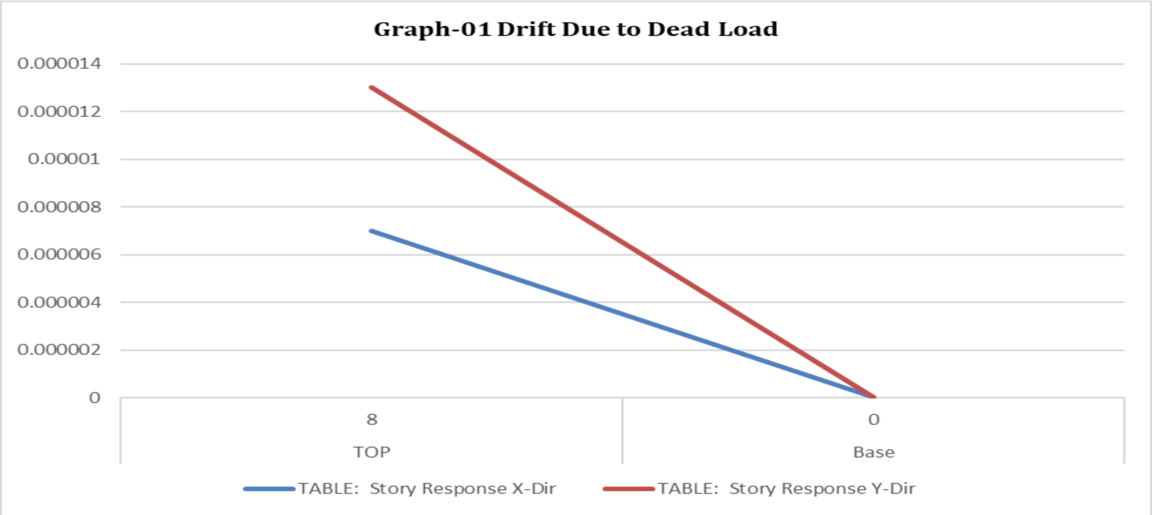


Figure06:Drift due to dead load.

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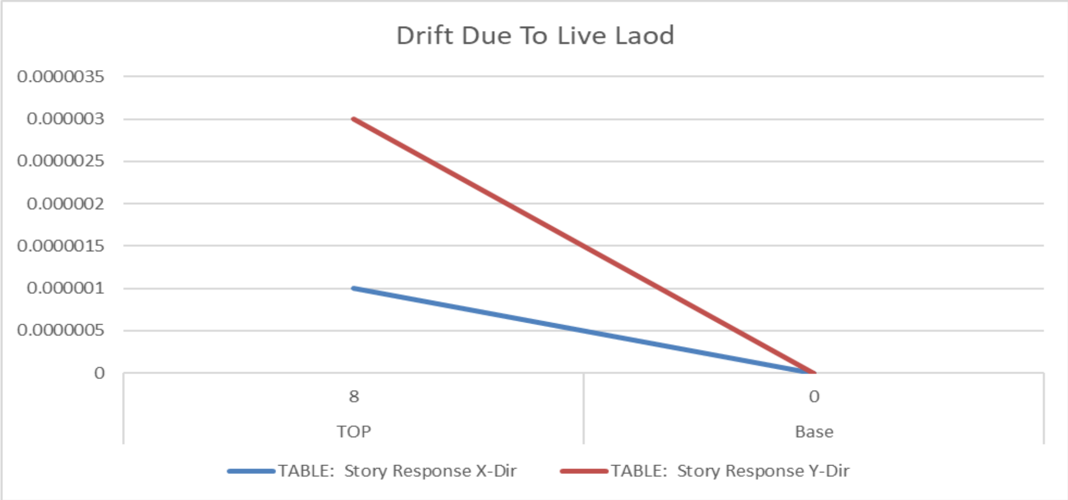

Figure07:Drift due to live load.

Over Turning Moment:-

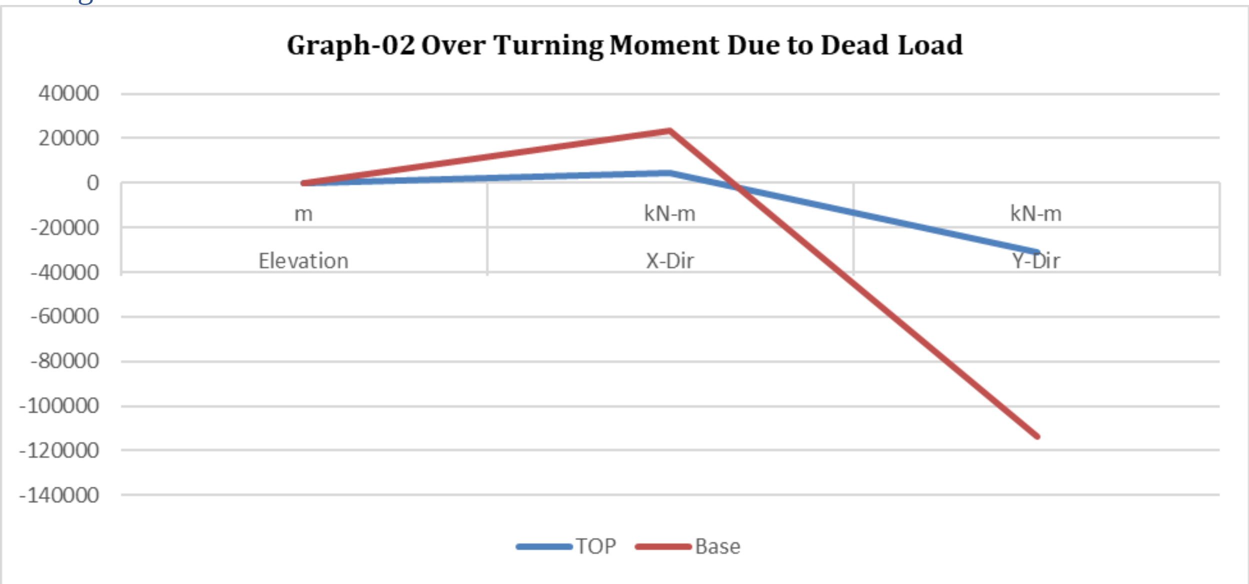

Figure08:Over turning moment due to dead load.

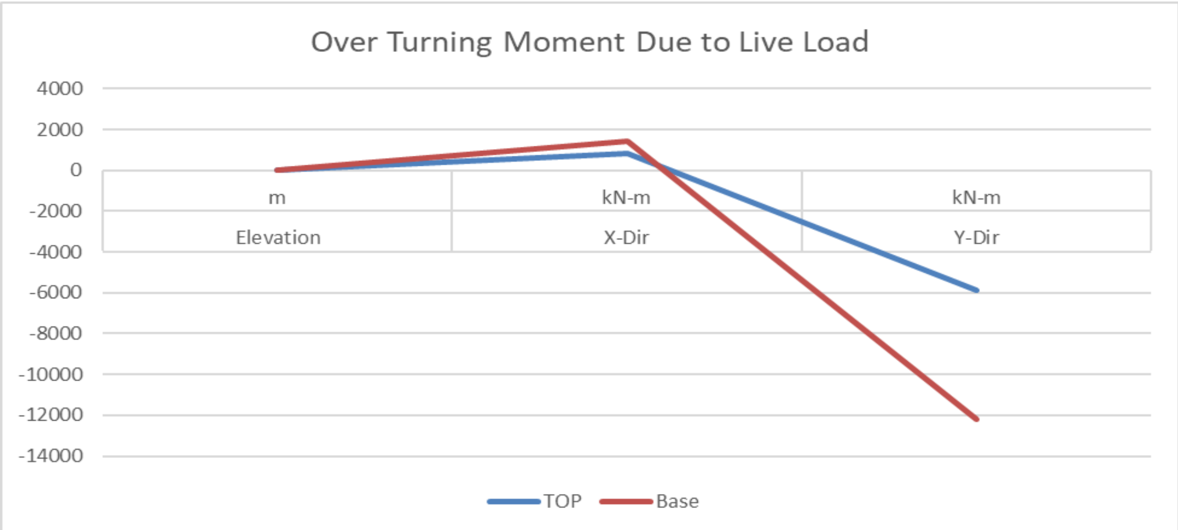

Figure09:Over Turning Moment due to live load.

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D. Max Displacement:-

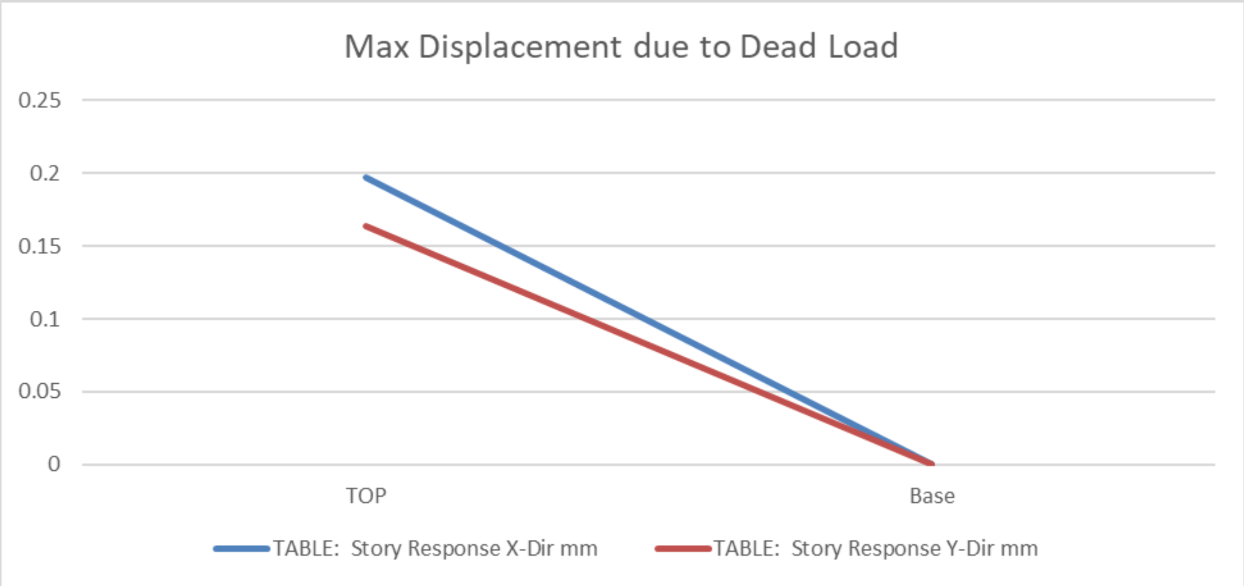

Figure09:Maximum displacement due to Dead load.

E. Stiffness:-

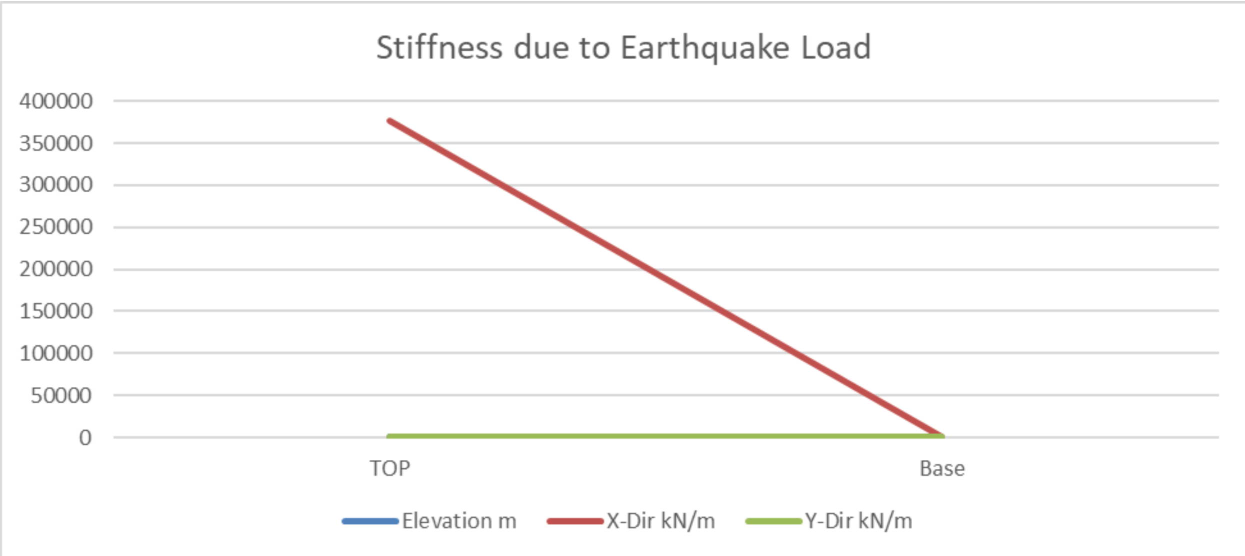

Figure10:Siffness due to earthquake load.

(II)ANALYSIS FIGURE:-

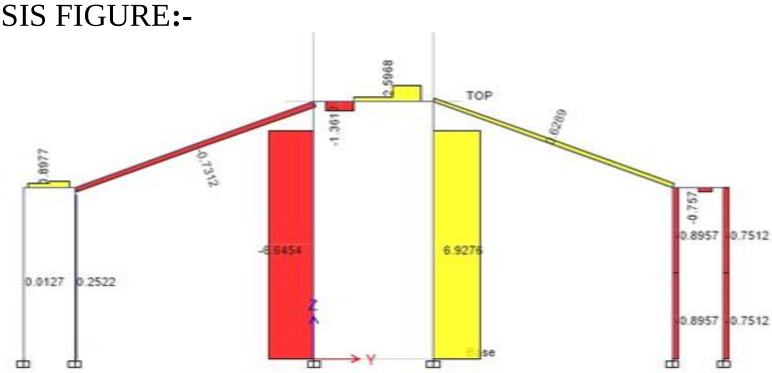

Figure11:Torsion due to DL

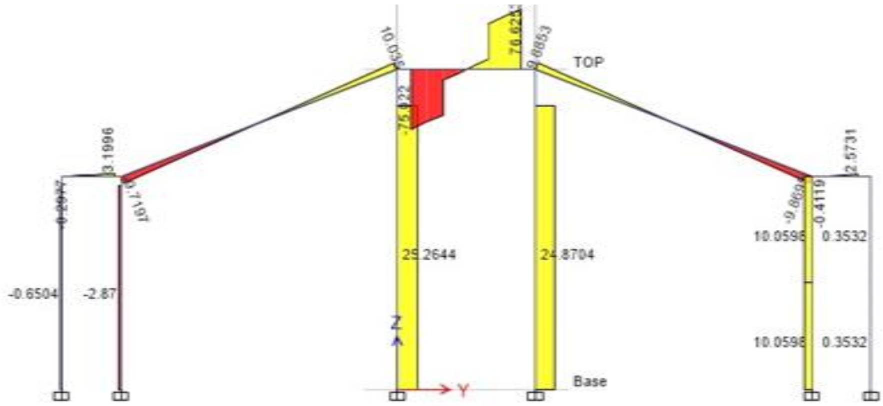

Figure12: Shear Force due to DL

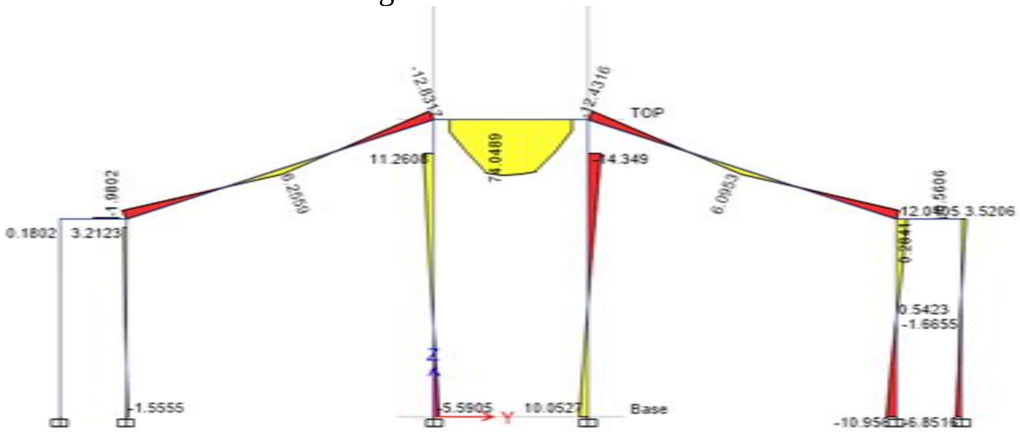

Figure13: Plane Moment due to DL

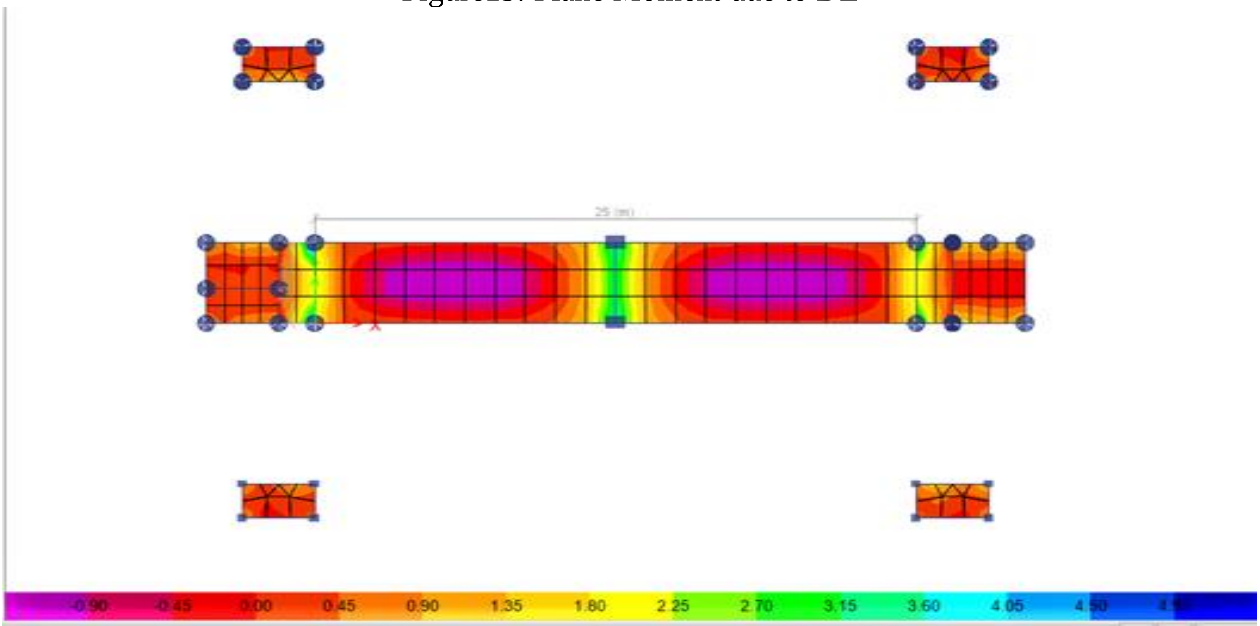

Figure14: Stress on Shell due to DL

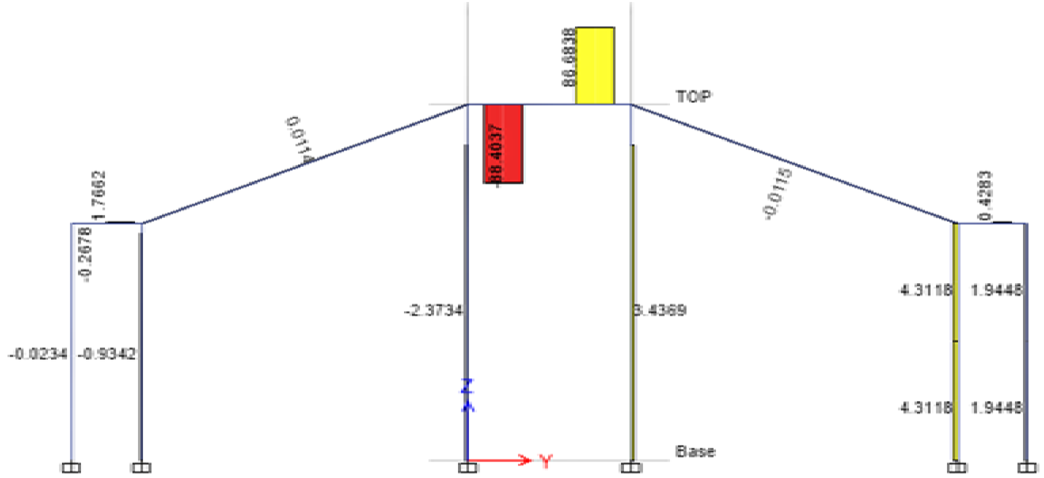

Figure15: Elevation View Shear Force due to DL

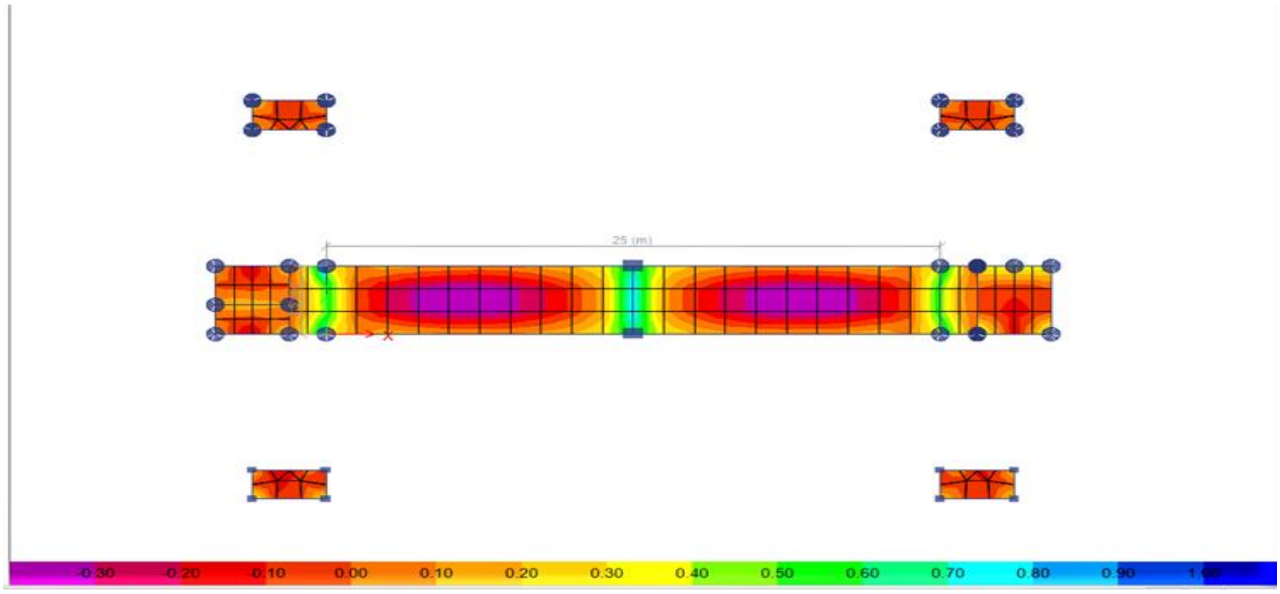

Figure16: Maximum Stress due to LL

Time History Analysis

Important Points for Time History analysis

Non linear – Responce isn't straightforwardly corresponding to Excitation

Function – Functions are defined to describe how the load varies as a function of period, time or Frequency

Response Spectrum Function – Spectral acceleration Vs Time period Time History Function – Loading Magnitude Vs Time Period

Types of time history analysis

(1)Linear Transient Or Non Linear Transient- It starts with Zero condition or previous linear/Non linear transient time history case

(2)Periodic – Initial condition is adjusted to be equal to those at the end of period of analysis Nonlinear time history is suitable for building with base isolators and dampers

Period – Time in second required by a function to complete one cycle

No. of steps – Value point provided for each cycle of function
Amplitude – Maximum function value
Natural Period/ Natural Frequency- Natural period is a time taken by a building to undergo one complete oscillation. The building offer least resistance when shaken by its natural frequency. Hence it undergoes larger oscillation when shaken by natural frequency than other frequencies. The natural period for structure is in the range of 0.05 to 2 sec.

Data For Time History Analysis:-
As per Indian standard code 1893 (part 1) : 2016 Time history method shall be based on an appropriate ground motion (preferably compatible with the design acceleration spectrum in the desired range of natural period) and shall be performed using accepted principles of the earthquake structural dynamics In this report, a nonlinear time history analysis will be performed on a multistory RCC building frame considering time history of EL CENTRO EARTHQUAKE 1940.All data are taken form PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER(PEER).

Description Of Elcentric Earthquake
Region: California
Latitude: 32.773N
Longitude: -115.5W
Depth: 16 km
Magnitute-6.9
Max. Intensity-X
Mechanism: Strike-slip

Strike degree-323
Dip Degree-80
Rake Angle-180

Hinge Properties in Pushover Analysis
There are three sorts of pivot properties in E-Tabs. They are

- Default hinge properties,
- User-defined hinge properties and
- Generated hinge properties.

Just default pivot properties and client characterized pivot properties can be appointed to outline components. At the point when these pivot properties are appointed to a casing component, the program naturally makes an alternate produced pivot property for every single pivot. The inherent default pivot properties are normally founded on FEMA-273 as well as ATC-40 measures.
we have Default-M3, Default-P, Default-P-M-M and Default-V2. Typically second pivot properties (Default-M3) are appointed to radiates and interfacing pivot properties (Default-P-M-M) are allotted to segments.

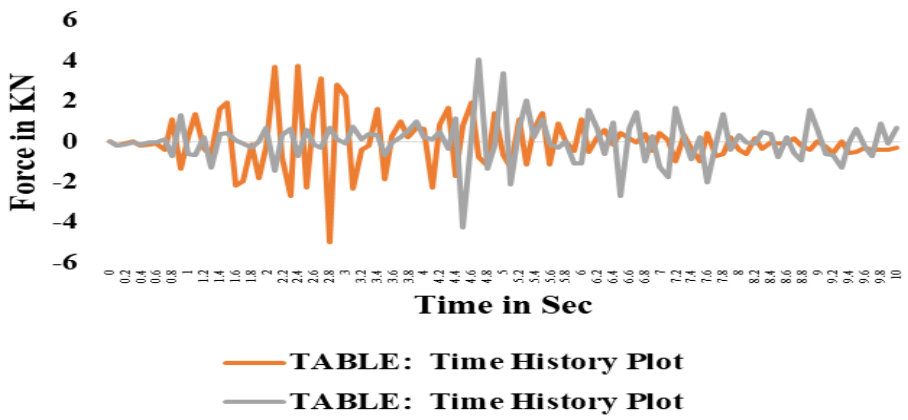

Figure18:Time History plot for base shea

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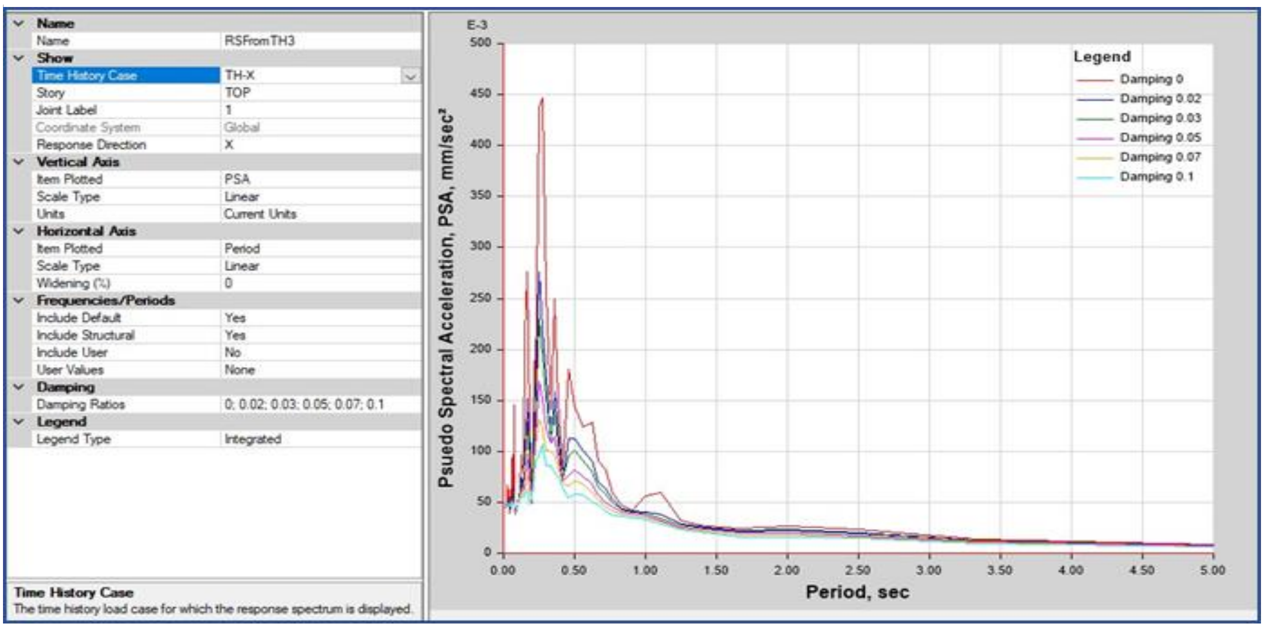

Figure19: Psuedo Spectral Acceleration due to Time History Function in X-direction

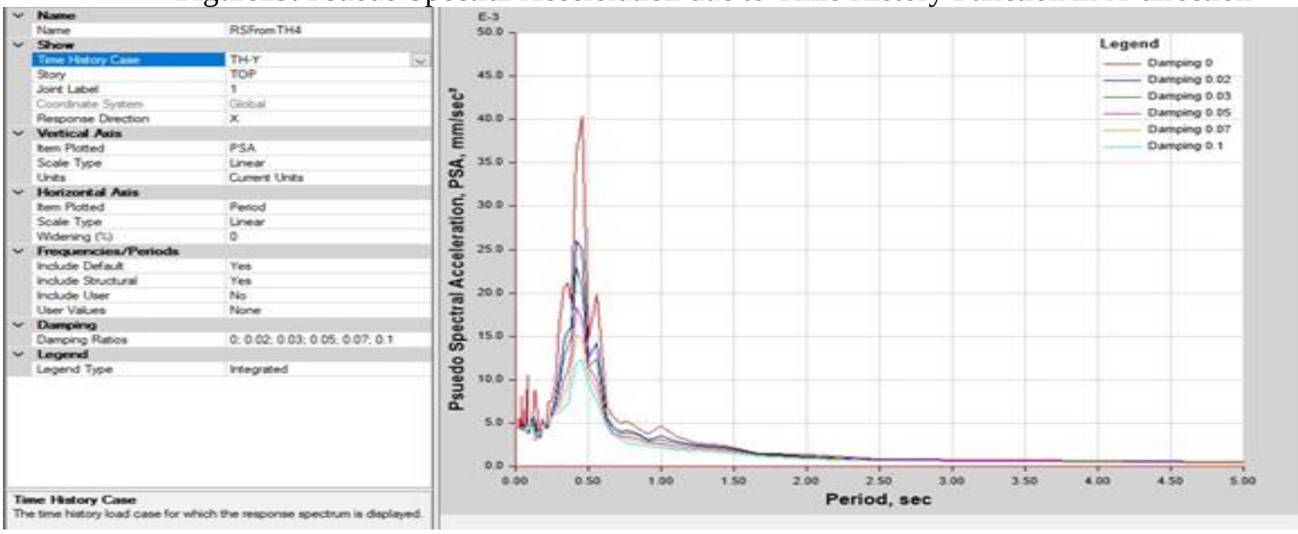

Figure 20: Psuedo Spectral Acceleration due to Time History Function in Y-direction

Economical Comparison

In some of the studies carried out by INSDAG, it is found that the Steel-Concrete composite option is cost effective (by about 8-10%) in Direct Construction Cost when compared with the conventional RCC construction. The Direct Construction Cost is the cost of the construction incurred during the gestation period of the project i.e. it is the investment. Usually the builder borrows capital from commercial banks at the Prime Lending Rate (PLR) of interest, which is considered in these studies as the Interest during Construction (IDC). Due to fast-track construction of composite structures, considerable saving in valuable construction time (about 25-30% if composite columns and beams only are used and about 40-50% if composite floor system is also included) could be achieved. The early finish of project will facilitate early return on the borrowed capital and as the least form of return, this amount is considered here as the rental charges

- RCC is cheaper when compared with other construction materials like Steel and pre stressed concrete. In future, the maintenance cost of RCC is also very low. So in all aspects, we can say that RCC is an economical construction material.

- RCC can be prepared and molded easily, at the site of construction. Also, the materials required for preparing RCC can be transported easily.
- RCC structures are more fire resistant comparatively to other construction materials like wood, Steel, etc.
- Maintenance cost of a steel structure is very high. Due to action of rust in steel, expensive paints are required to renew time to time. So that resistance against severe conditions increases.
- Steel has very small resistance against fire as compared to concrete. Almost from 600-700C half of steel strength reduced.
- Steel cannot be mould in any direction you want. It can only be used in forms in which sections originally exists.
- If steel loses its ductility property, than chances of brittle fractures increase.
- If there are very large variations in tensile strength than this lead steel to more tension. Due to which steel tensile properties graph falls down.

IX. Conclusions

This research has focused on a design approach for steel and concrete bridges. Two design stages have been considered, and the research fields related to that phases have been reviewed. In this research fields are Design And Behavior (75%), Optimization (10%), Construction Process (5%), Maintenance and Repair (5%), Life Cycle Assessment (5%), and Multi-Criteria Decision-Making (5%). To improve the literature review, a statistical analysis has been carried out to look for relations between fields of study, design stages, and bridge cross section types and push over analysis.

- Most effective utilization of materials viz. concrete in compression and steel in tension.
- High ductility of steel leads to better seismic resistance of the composite section. Steel component can be deformed in a ductile manner without premature failure and can withstand numerous loading cycles before fracture.
- Steel component has the ability to absorb the energy released due to seismic forces through its unique property called ductility.
- Ability to cover large column free area. This leads to more usable space. Area occupied by the composite column is less than the area occupied by the RCC column.
- Quality of steel is assured since it is produced under controlled environment in the factory under strict Quality Assurance Plan (QAP). More use of steel in composite construction compared to that in RCC structure ensures better quality control. Cost effective, based on life cycle cost analysis since steel structures can be maintained easily and less frequent repairs are required for steel structure.

Steel is more durable, highly recyclable and hence environment friendly. Keeping span/loading unaltered, smaller structural sections are required compared to non-composite construction. Therefore, reduction in overall weight of the composite structure compared to the RCC construction results lesser foundation costs. Cost of handling and transportation is less because major part of structure is fabricated in workshop near the site. The steel component and hence the steel-concrete composite construction is more resistant against accidental loads compared to RCC construction.
Composite sections have higher stiffness compared to only steel construction and hence experience lesser deflection than the non-composite steel sections.

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