"Analysis and Design of Multi-storey flyover with different types of load and problems occur in design with SAP2000"

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Abstract—*The principle objective of this project is to design and analysis six lane flyover using SAP2000. The flyover is of 400m length with width of 15 m. The diameter of the pier is about 2.5m and the Beams are of I-section. The height of the columns is 4.2m. The Flyover has a road width of 15 m, in which 0.5m is of median. In the post processing mode after completion of the design we have worked on the structure and studied the bending moment and shear force values.*

Key Words: Fly over, design parameters, bending moment shear force, post processing, SAP2000

INTRODUCTION

Flyovers are often built over roads or railway tracks to handle excessive traffic. If the areas are left empty, you can do other things during building. Overloading high-rises can damage them. Due of substructure instability, construction flyovers collapse; building new ones may cost money. Building long-lasting structures is as important as repairing/maintaining broken ones.

Flyovers vary by purpose and location. Flyovers connect two sites across a valley, river, sea, or other natural feature. Flyovers connect busy roadways and intersections. Flyovers allow travel over obstacles without closing the road below. Roads, railways, and valleys need passage. Flyover design requires inventiveness, practicability, safety, and economics. A structure should be constructed to withstand all action anticipated to occur within its lifespan with a stated probability. The construction must also be stable and durable during extreme motion.

India is known for its steel flyovers. These are road flyovers over low terrains or intersections connecting great distances with single or multiple spans. Steel flyovers are suited for large spans, hilly construction, and terrain conditions. Short- and medium-span flyovers Steel-concrete composite construction is growing. Steel Flyovers in India have lasted 100 years or more. Most Indian cities are saturated due to high population density and traffic congestion. Flyovers solve this. R.C.C flyovers take time, disrupt traffic, and have limited seismic resistance. Although expensive, steel flyovers can solve these drawbacks. Flyovers have three components. First, the substructure (foundation) uses columns (piers) and abutments to support the Flyover and flyover's weight. An abutment supports the end of the flyover and road carried by earth.

Types of Flyover

1. Railway crossing
2. Road crossing

Parts of Flyover

1. Super structure
2. Sub structure Super structure

The superstructure consists of the components that actually span the obstacle the bridge is intended to cross and includes the following

- Bridge deck
- Structural members

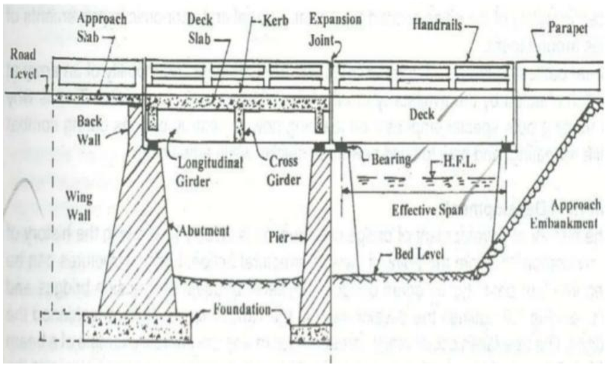

Fig1.1: Components of fly over (https://thelibraryofcivilengineer.wordpress.com/type/gallery/)

Loads on Flyover

1. Dead load
2. Live load
3. Dynamic load
4. Other loads IRC Class 70R Loading:

This loading is to be normally adopted on all roads on which permanent bridges and culverts are constructed. Bridges designed for Class 70R Loading should be checked for Class A Loading also as under certain conditions, heavier stresses may occur under Class A Loading

It is also necessary to eliminate the over Flyovers that remain futile and which pose a threat to the environment. The fact is that, their roles are productive at the beginning stage and as days go on, they lose their originality in the sense of reduction in their structural stability. In the construction of over Flyovers, loop/ square topologies were addressed to help in concluding which one suits more.
Proper planning is the most important thing and only after sufficient testing, the built structures must be left for service. Occurrence of problems is common when considering the oversized trucks into account. Smart systems were introduced which deliberately alarm when oversized vehicles head to the flyover. In this case, these vehicles are stopped for a while to pave way for other vehicles to leave from the Flyover in-order to avoid collision. Since this approach is costlier, computer aided mechanism replaces the previous one. Still, this system delays the vehicles and makes them wait.
So, an ideal flyover construction must be built that is strong enough to hold any number of huge vehicles that passes by. Vibro pile construction is elaborated where 318 piles are considered for analysis. It is stated that this type of pile foundation could be preferred for low-volume overpasses. Continuous flight auger piling system was used which is highly recommended in areas where the water table volume is more. Extensive studies and experiments are essential to verify its structural integrity by ensuring apt auger rotation. Furthermore, by economic means, it is not suitable for low budget constructions.
Flyover pier testing such as core and pull-out/off tests are conducted to determine the basic functionalities including thickness, elastic modulus, structural integrity, surface absorption, etc. From the case study of the T-beam girder made of concrete, it is found that the strength of the piers should have been improved by adding reinforcement or other means. By the inclusion of reinforced concrete, occurrence of disintegration of structures because of beam-column interaction is preventable.

Problem Statement

"By studying different examinations like road survey and traffic analysis that the problem at city by pass road is due to insufficiency of road space for the vehicles to pass through the junction at different instants of time in a day which is effecting the free flow of traffic, and improper movement of traffic also results in occurrence of accident in different instants of time."

Aim

"Design of Double stage flyover with different types of load and problems occur in design with SAP2000"

Objectives

- The main objective of designing of Fly-over Bridge on major junction to avoid excessive traffic.
- To study and to make the suggestion and improvement in transportation by providing fly-over bridge for excessive traffic.
- The project area is having very high density of traffic flow. The public felt inconvenient to cross the busy four roads highways &therefore the flyover is essentially required at the junction.
- For Smooth traffic flow of industrial goods and agricultural goods without traffic congestion flyover is essential to overcome the traffic congestion required.
- The Pier is designed for the axial dead load and live load from the slab, girders, deck beam. Foundation designed as footing for the safe load bearing in the soil.
- Design and analyze the flyover using software SAP 2000
- To minimize the traffic delay due to heavy traffic & to suggest the fly-over with good Aesthetic and Architectural view.

Analysis and Design of single pier double decker flyover by using SAP2000

- In Rigid or Flexible pavement road of national highway the structure are design for s per IRC SP 84.
- Flyovers are design on 19 separate piers for lanes.
- We are going to design a Flyover on 19 pier and lane having deck slab 350mm.
- We are going to take this location in congested city area.
- Total length of structure will be 400 mtr having spanned, it will be consist of 1 nos. obligatory span, 9 nos. of pier of dia. 2.5m
- The foundation type will be open foundation and pile foundation.
- Superstructure will be of segmental type consist of precast wing and precast spine beam, wearing coat.
- There will be also curve section span in flyover.

Project Comparison:

- The comparison will be done for design effect for pier and 19 pier flyovers with estimate cost of view, project completion time of view.
- The project cost comparison will be also as per limitation of ROW and land acquisition, as we know construction of highway project land acquisition is a major part which affects the cost of project. Also, it affects the project by financially and time lapse.
- We will also discuss the land which is saved due to construction of structure on single pier.
- The project design will be done on SAP2000 and using various guideline of MORT&H, IRC Specification, and procedure for acquisition of land as per government guidelines.

Design & Modelling

Input Data Flyover Design

- Length 400m
- Width 15. M
- Class 70r, IRC Class A Track
- IRC Class A Wheel
- Pier 2.5 M Dia
- No Of Pier 19

- BEAM 1.5mm x1.5 mm (Longitudinal Beam Along X-axis)
- BEAM 1200mm x 2 m (Longitudinal Beam Along Z-axis)
- Deck Slab Thickness 350mm
- LOADING
- Dead Load, Bridge Live Load, Live Load, Earthquake Load X And Y Direction

Design of 3D View of Double Decker flyover using I Girder

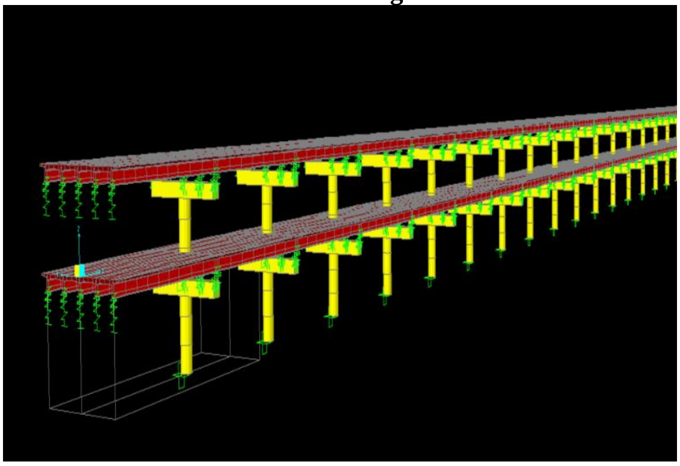

Figure.1.1: 3D view of Model

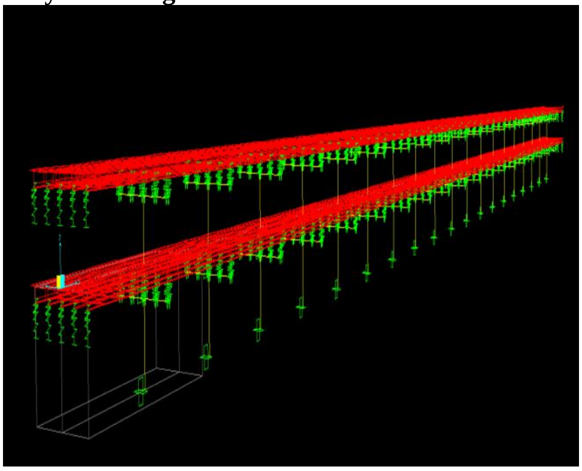

Figure1.2: 3D VIEW BRIDGE MODEL2

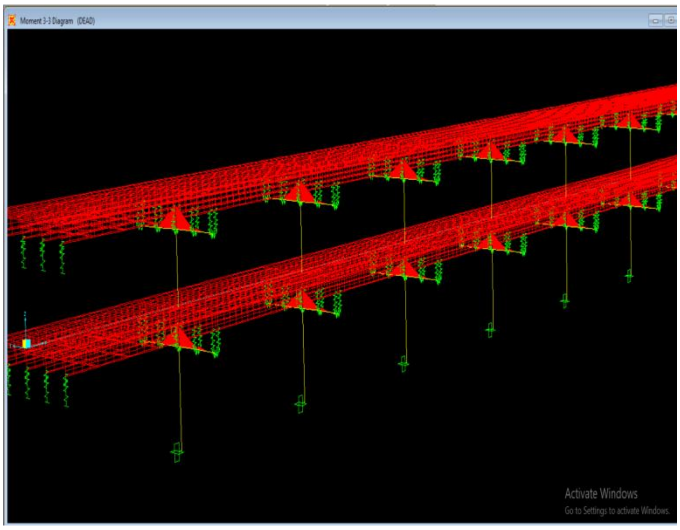

Figure1.3: Bending moment diagram 3D view

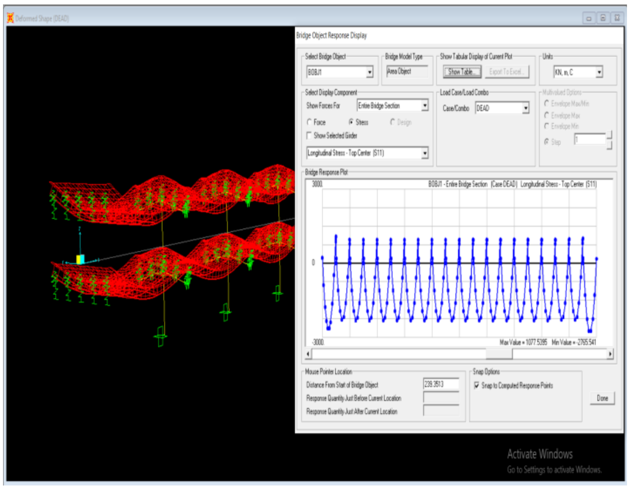

Figure1.4: Bridge response due to loading (longitudinal stress diagram, max and min)

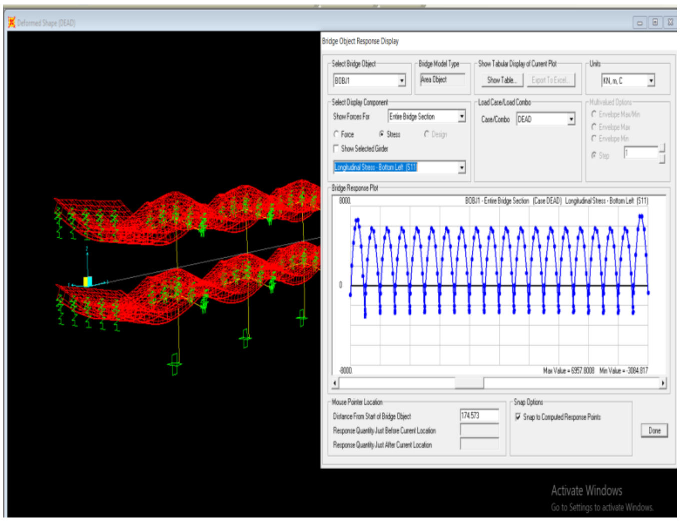

Figure1.5: Bridge response due to loading (longitudinal stress at bottom left side, max and min)

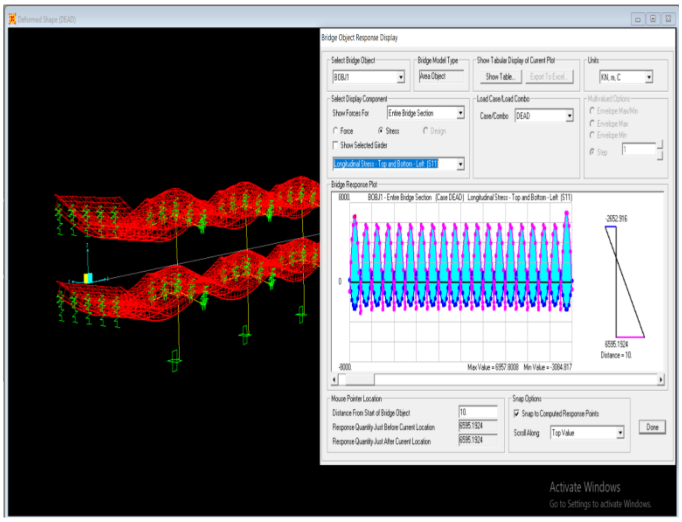

Figure1.6: bridge response due to loading (longitudinal stress at top and bottom left side, max and min)

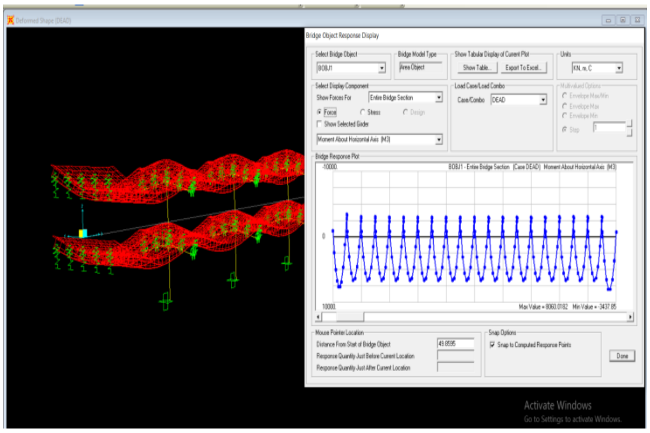

Figure1.7: bridge response due to loading (moment about horizontal axis diagram, max and min)

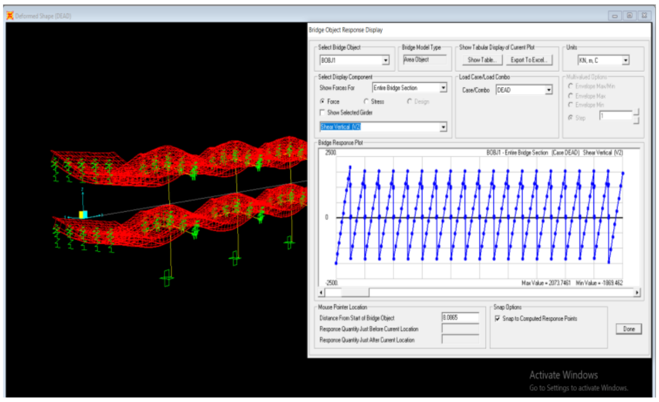

Figure1.8: Bridge response due to loading (Shear vertical diagram, max and min)

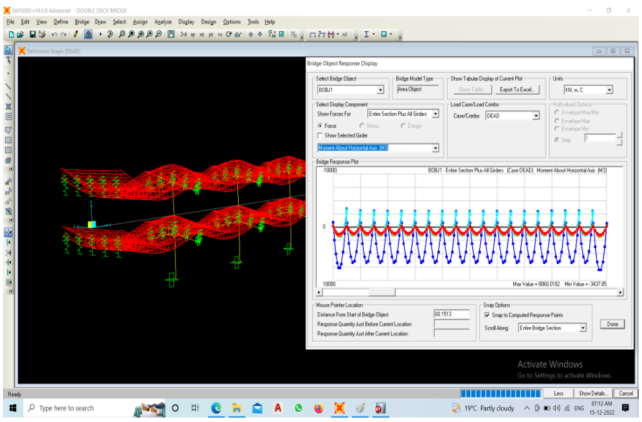

Figure1.9: Bridge response due to loading entire section plus all girder (moment about horizontal axis, max and min)

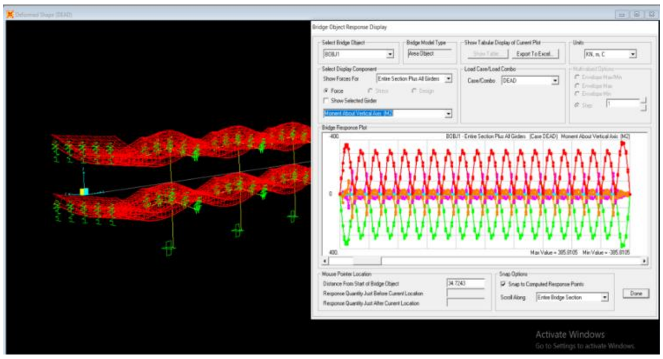

Figure1.10: Bridge response due to loading entire section plus all girders (moment about shear vertical, max and min)

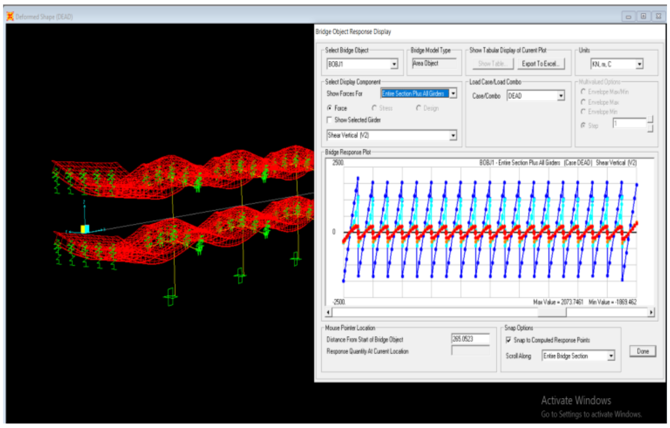

Figure1.11: Bridge response due to loading entire section plus all girder (shear vertical, max and min)

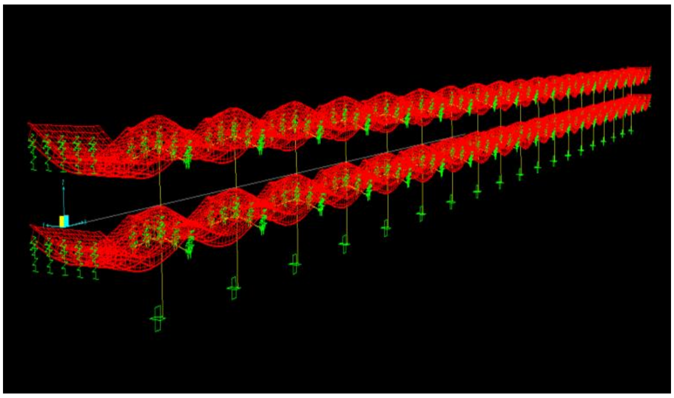

Figure1.12: Displacement due to all loading

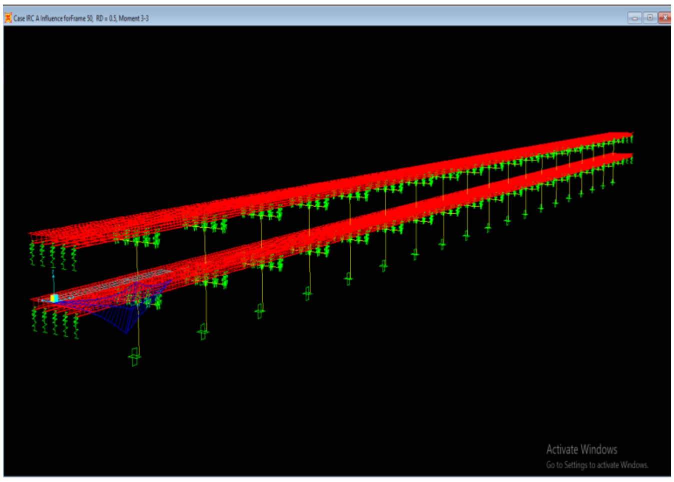

Figure1.13: Influence line diagram on frame due to moment

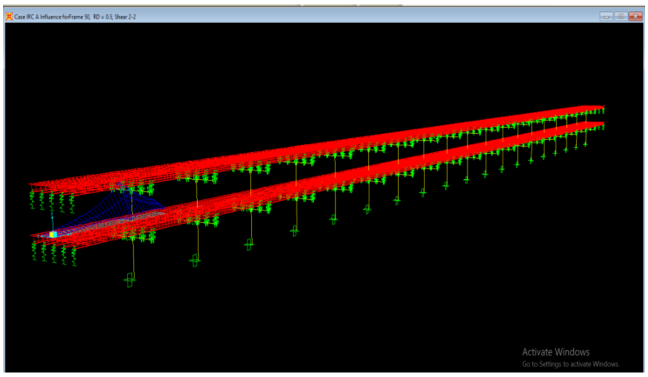

Figure1.14: Influence line diagram on frame

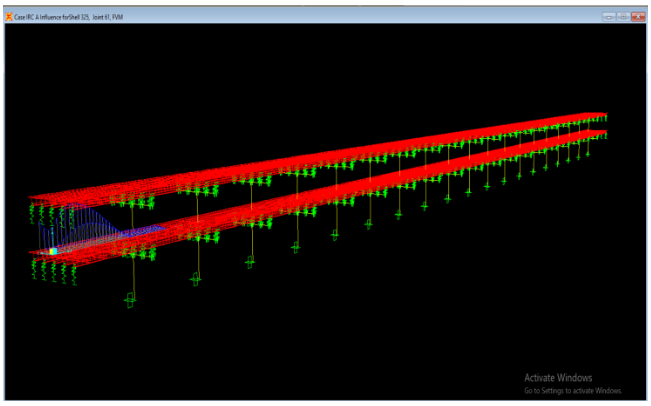

Figure1.15: Influence line diagram on shell due to IRCA loading

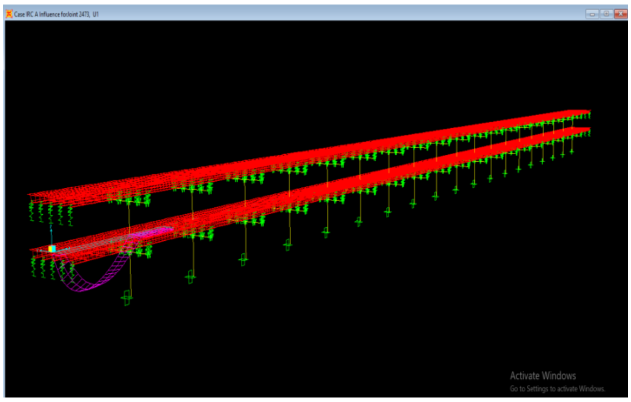

Figure1.16: Influence line diagram

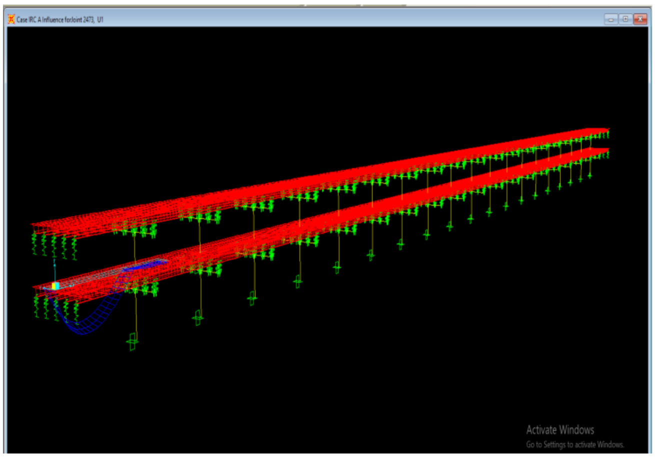

Figure1.17: Influence line diagram2

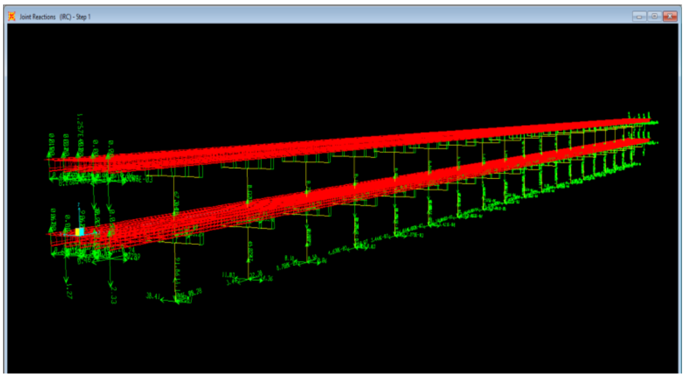

Figure1.18: Joint reaction due to IRC loading

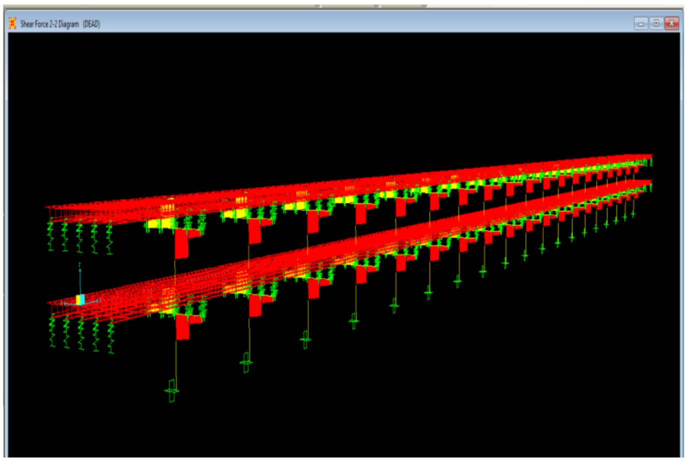

Figure1.19: Shear force diagram 3D view

DESIGN AND MODELLING – PART-II

2. Design work on U-Girder Design

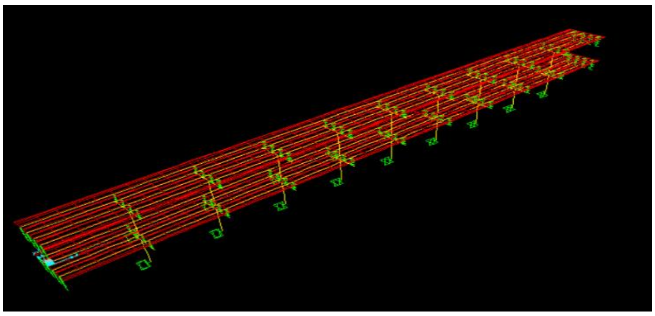

Figure2.1: 3D Model Work of U-Girder Bridge Work

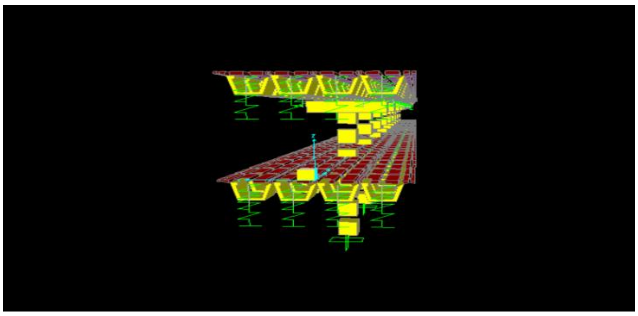

Figure2.1: U-Girder Design

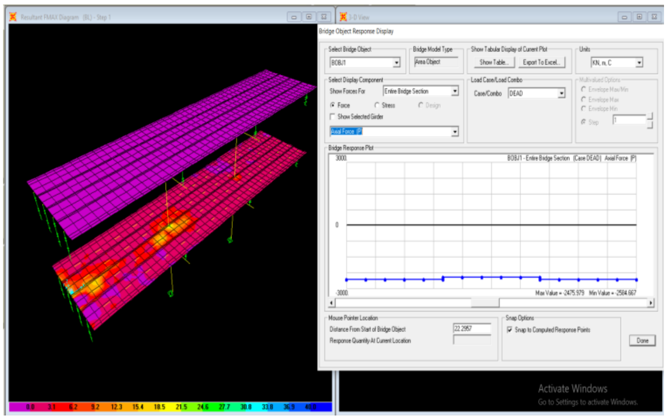

Figure2.3: Axis Force Due to Reaction

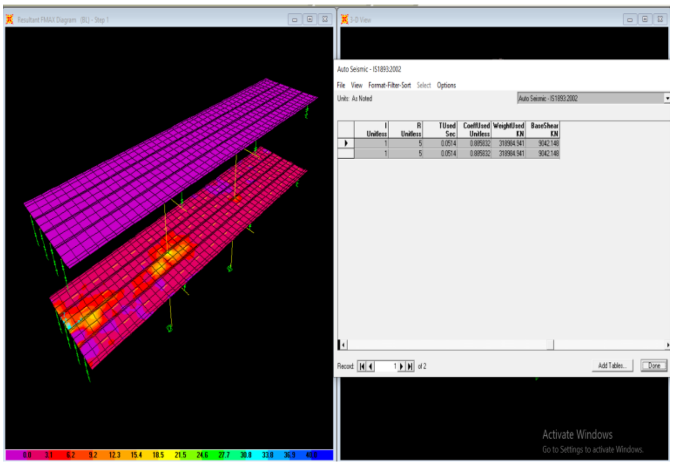

Figure2.4: Base shear 9042 KN

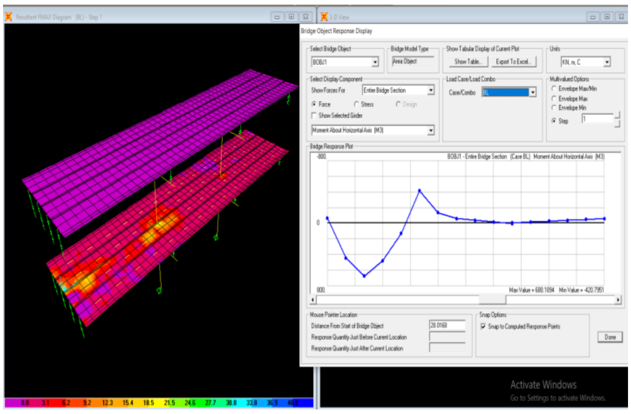

Figure2.5: Bending Moment Direction

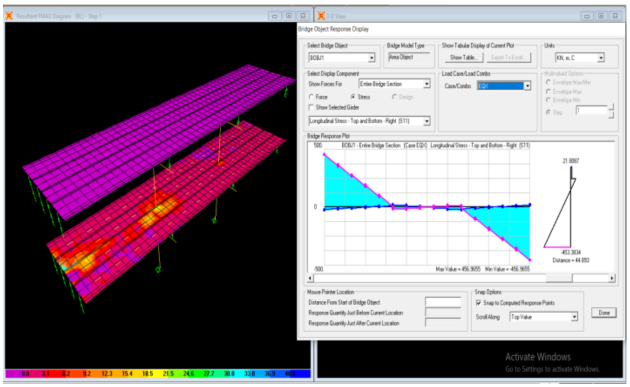

Figure2.6: EQX and top and bottom

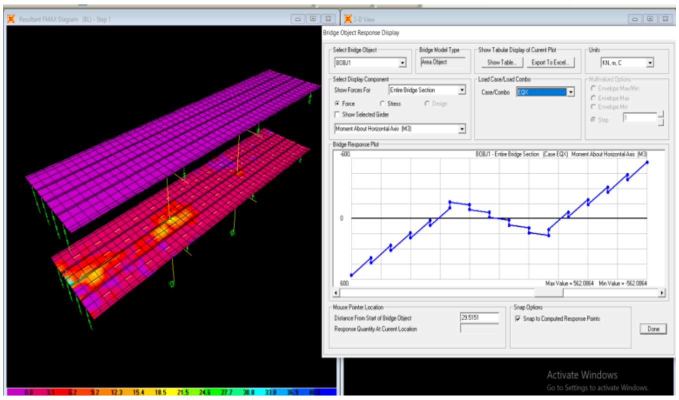

Figure2.7: EQX Reaction

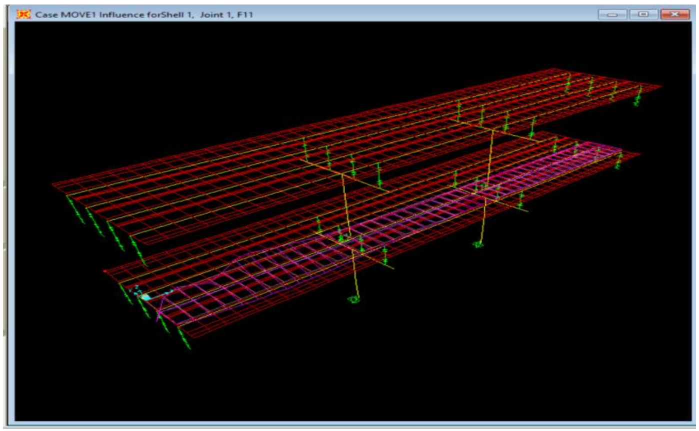

Figure2.8: Influence line diagram 2

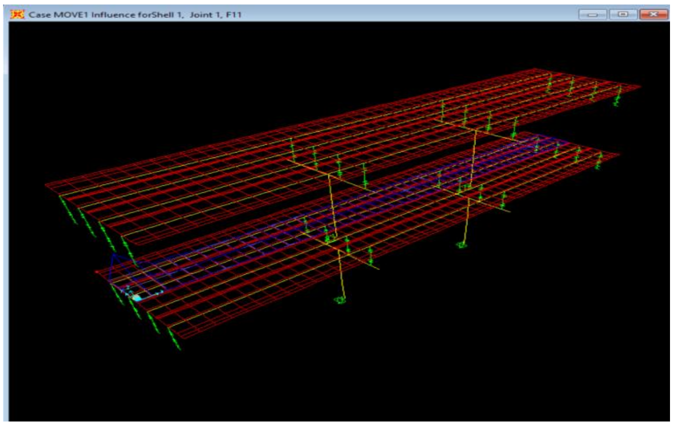

Figure2.9: Influence line diagram

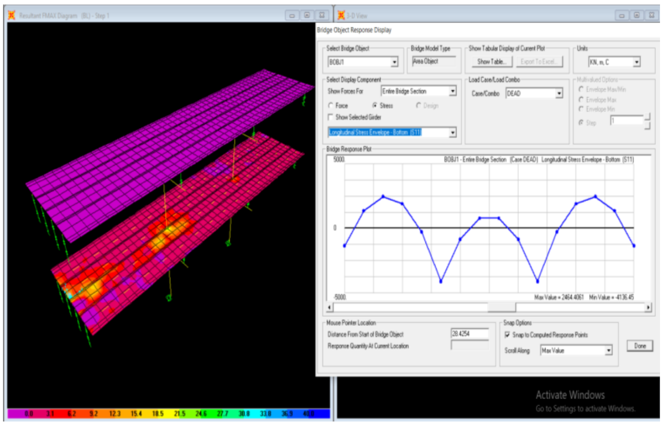

Figure2.10: Longitudinal stress at bottom

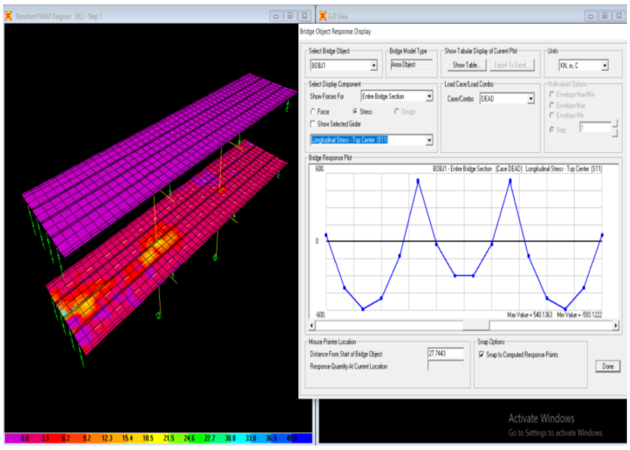

Figure2.11: Longitudinal stress at plate

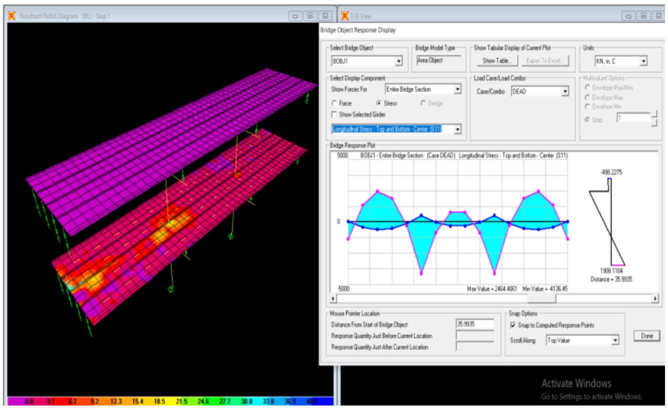

Figure2.12: Longitudinal stress at top and bottom

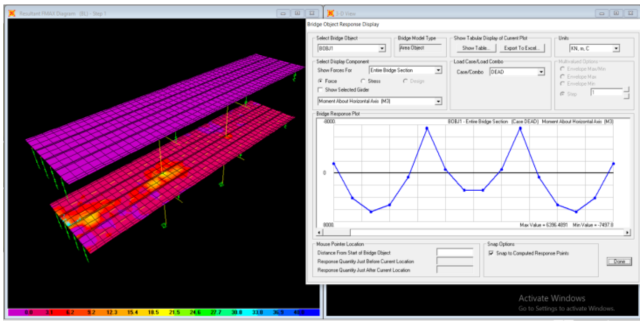

Figure2.13: Moment about horizontal axis

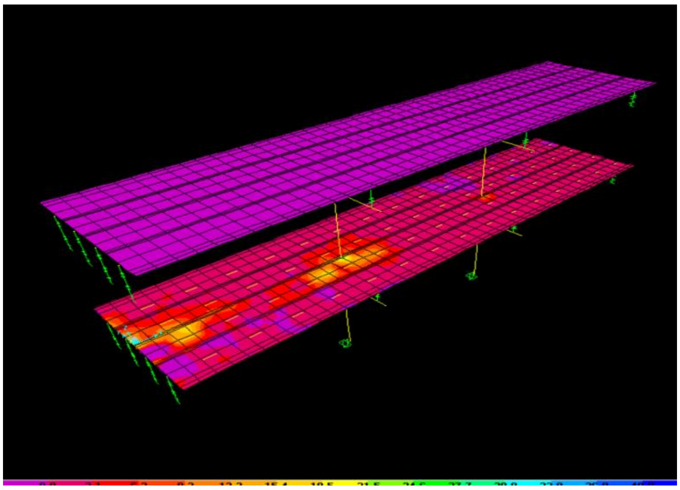

Figure2.14: Plate Force Due to Loading

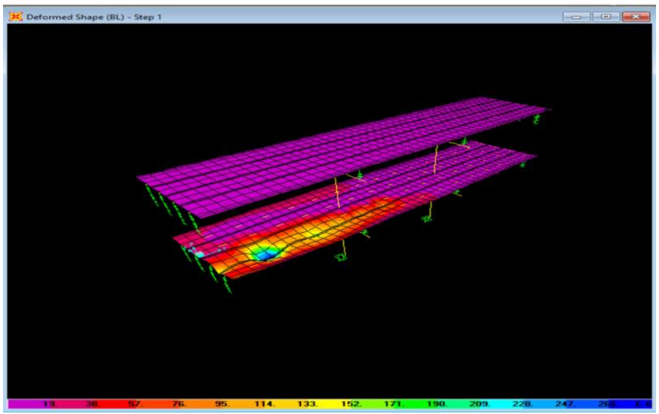

Figure2.15: Plate Stresses Due to Vehicle Load

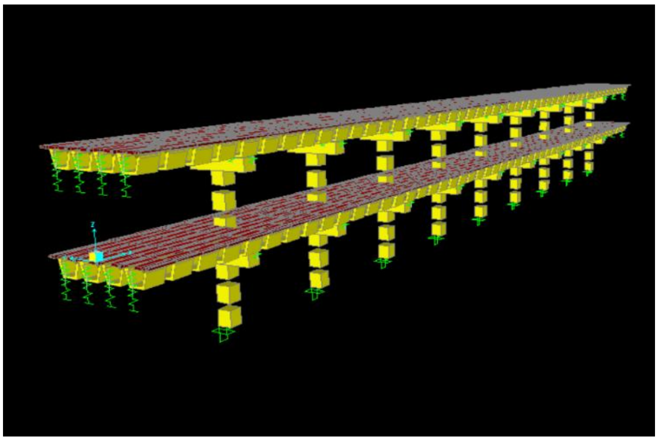

Figure2.16: Render View

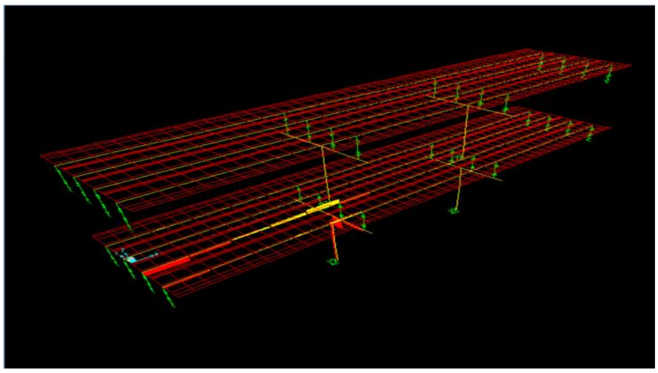

Figure2.17: Shear Force

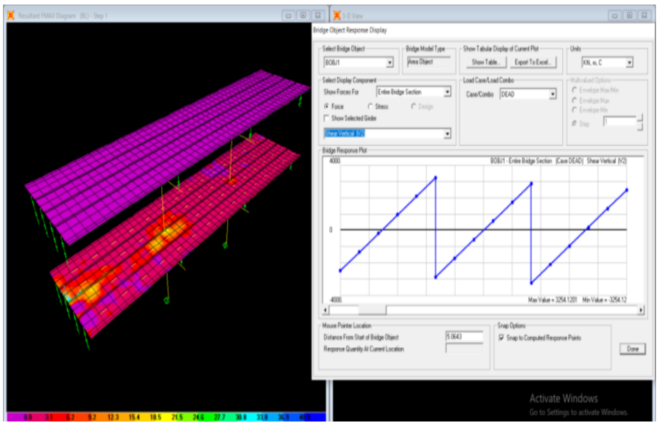

Figure2.18: Shear vertical (v2)

TABLE: Auto Seismic - IS1893:2002							
Load Pat	Dir	Z Code	Soil Type	I	R	T-Used	Base Shear
Text	Text	Text	Text	Unitless	Unitless	Sec	KN
EX	X	0.36	II	1	5	0.5948	15455.706
EY	X	0.36	II	1	5	0.5948	15455.706

TABLE: Base Reactions			
Output-Case	**Step-Type**	**Global-FZ**	**Global-MY**
Text	Text	KN	KN-m
DEAD	0	187764.593	-37488753
IRC A	Max	5040	0
IRC A	Min	0	-146186.656
IRC	Max	554	0
IRC	Min	0	-12445.0489

Modal Periods And Frequencies				
StepNum	**Period**	**Frequency**	**CircFreq**	**Eigenvalue**
Unitless	Sec	Cyc/sec	rad/sec	rad2/sec2
1	0.826176	1.2104	7.6051	57.838
2	0.813783	1.2288	7.721	59.613
3	0.792242	1.2622	7.9309	62.899
4	0.761076	1.3139	8.2557	68.156
5	0.720841	1.3873	8.7165	75.977
6	0.673431	1.4849	9.3301	87.051
7	0.621736	1.6084	10.106	102.13
8	0.594794	1.6813	10.564	111.59
9	0.568896	1.7578	11.045	121.98
10	0.549593	1.8195	11.432	130.7
11	0.51759	1.932	12.139	147.36
12	0.493494	2.0264	12.732	162.1

Force act on entire section plus all girders		
Bridge object response Display (due to loading)		
1	Maximum Shear Vertical	2074.74
2	Maximum longitudinal stress (Top centre)	1077.54
3	Maximum Longitudinal stress (Bottom left)	6957.8
4	Max moment about horizontal axis	8060.01
5	max moment about vertical axis	385.81

CONCLUSION

- This structure will be reducing the traffic control and enhances the safe driving.
- The structure will be designed as per IRC class loading.
- This project helps to improve the urbanization of rural areas
- Also facilitate the connection of various system of road such as village road, state highway, national highway etc.
- This project concludes with planning, design, and analysis of a fly over.
- Based on study area flyover construction is best and economically low cost which is essential at National Highway NH which is always busy with traffic moment. Located at Solapur junction in Hyderabad Naka, Maharashtra, India.
- The maximum flow of traffic is along National Highway NH64 which includes transportation of agricultural goods and industrial goods, so path chosen for the execution of flyover is along at National Highway NH65.
- Construction of this structure at that junction results in the traffic control and enhances safe driving.
- Analysis of proposal of Prestressed concrete bridges are carried out using relevant IRC codes and IS codes

- For self-weight of girder condition: The maximum shear vertical force is found as 3315.51 KN at U Girder Bridge. The maximum bending moment is found as 6831.26 KN-m from the face of the girder.
- For self-weight of girder condition: The maximum
- shear vertical force is found as 2074.74KN at I Girder Bridge. The maximum bending moment is found as 8060.01 KN-m from the face of the girder.
- Maximum Longitudinal Stress at top in I girder 1077.54 and U girder 607.54 mpa and at bottom side 6957.8 and 2962.67 mpa which show that in I girder more stress due to loading as compare.
- Structure is designed based on IRC class A and IRC 70R loading. IRC Loading is only applied for justification of bridge girder analysis.
- Amount of steel provided in U Girder Bridge as comparative to I girder the structure is economic.
- In this comparative analysis it is clearly stated that u Girder Bridge is more stable in resisting load. But it is also concluded that in terms of cost U girder is more costly comparative to I girder.

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REFERENCES

[1]. Girder Longitudinal Movement and Its Factors of Suspension Flyover under Vehicle Load Guoping Huang, Research Article, 1 October 2021
[2]. DYNAMIC BEHAVIOUR OF FLYOVER GIRDERS WITH TRAPEZOIDAL PROFILED WEBS SUBJECTED TO MOVING LOADS,ZHIYU WANG, YUNZHONG SHI, MDPI 2021
[3]. Analysis For Earthquake-Resistant Of Flyover Structure Subjected Two Earthquakes, Liu Chunguang, MDPI 2021
[4]. Comparative Analysis and Design of Steel Foot Flyover using Conventional and Hollow Section Anushka M. Pachpute, Nikita J. Patil, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Elsevier 2020
[5]. Numerical Examination of Reinforced Concrete Skew Slabs Boobalan S C, Abirami P, Indhu K, International Journal of Innovative Technology and Exploring Engineering (IJITEE), March 2021
[6]. Design and Analysis of Flyover, Bismi M Buhari International Journal of Engineering Research & Technology (IJERT), July-2021
[7]. Comparative Study of Grillage Analogy and Finite Element Method for Flyover Heavy Load Assessment, Shojaeddin Jamal, Tommy H.T. Chan
[8]. Analysis and Design of Foot Flyover Connecting (2nd Floors) of Block A and Block B of MIET, Jammu Akhil Sharma, Ashwani Kumar, Sunil Sharma, Arun Singh Chib, International Journal of Engineering Research & Technology (IJERT), May-2020
[9]. Behavior of Composite Steel Flyover Beams Subjected to Various Posttensioning Schemes WILLIAM E. WILEY, TRANSPORTATION RESEARCH RECORD
[10]. Comparative analysis of t-beam flyover by rational method and staad pro praful n k , balaso hanumant, international journal of engineering sciences & research technology
[11]. A Computational Approach of Pre-stressed Concrete Flyover Deck Slab Analysis for various IRC Classes of loadings using Pigeaud Charts Dr. M. Siva
[12]. A Comparative Study on T Girder Flyover Deck using Grillage Analogy and Finite Element Method, Gaurav Somani, International Journal of Engineering Research & Technology (IJERT), June-2021
[13]. Comparative study of Grillage method and Finite Element Method of RCC Flyover Deck R.Shreedhar, Rashmi Kharde, International Journal of Scientific & Engineering Research Volume 4, Issue 2, February-2013
[14]. SOCIAL IMPACT ASSESSMENT OF ROAD INFRASTRUCTURE PROJECTS Ms Nirali Shukla & Dr. H.J.Jani, (January-February, 2018)
[15]. Flyover Engineering Handbook Superstructure Design, Wai-Fah Chen, Lian Duan, 19 Oct 2021
[16]. Analysis and Design of Skew Flyovers Nikhil V. Deshmukh, International Journal of Science and Research (IJSR) 2018
[17]. DESIGN OF FLYOVER TRANSVERSE VERTICALLY BY USING HYDRAULIC JACK, M. Hari Sathish Kumar, K. S. Binitha, K. Balaji, International Research Journal of Engineering and Technology (IRJET), 11 Nov 2017
[18]. Analysis of Skew Flyovers Using Computational Methods, Vikash Khatri, P. R. Maiti International Journal of Computational Engineering Research,
[19]. Nonlinear Analysis of Reinforced Concrete Flyovers under Earthquakes, Hong-Nan Li, International Conference on Advances in Experimental Structural Engineering, 2019
[20]. Design of Flyover Construction based on Fibre Reinforced Concrete and Timber Pile Foundation J Prakash Arul Jose, International Journal of Applied Engineering Research, 2022
[21]. Review Of Annual Progress Of Flyover Engineering In 2019, Renda Zhao, Yuan Yuan,
[22]. Seismic Performance Of Precast Flyover Columns Connected With Grouted Corrugated-Metal Duct Through Biaxial Quasi-Static Experiment And Modeling, Xia Zhanghua, Lin Shangshun, 16 July 2021