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ANALYSIS OF FLYOVER STRUCTURES WITH DIFFERENT LOADS

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ABSTRACT

Fly- over's have been constructed since early seventies. They are mainly constructed for the purpose of traffic congestion elimination. However planning, design, construction, and erection of fly-over consume great span of time. The same have been the case with the emerging fly-over over NH By-pass, ONGOLE, and spanning 600m with a width of 6.6m. Greater seismic resistance, life span, and lesser life cycle cost nullify the excess cost of construction of flyover. Bridges and fly-over's are structures providing passage over an obstacle without closing the way beneath. The required passage may be for a road, railway or a valley. Bridge design is a complex problem, calling for creativity and practicability, while satisfying the basic requirement of safety and economy. The basic design philosophy governing the design is that a structure should be designed to sustain, with a defined probability, all action likely to occur within its intended life span. In addition, the structure should maintain stability during unprecedented action and should have the adequate durability during its life span.For easy traffic flow of vehicles without traffic congestion flyover or over bridges is essential to overcome the traffic congestion required. Our project deals with the Design of a flyover in the intersection. The location is at four roads junction at pipeline junction, which is facing major traffic problems due to the construction.

KEYWORDS: Flyover, construction, load analysis.

INTRODUCTION

For designing a new structure, connection details and support conditions shall be made as close to the computational models as possible. For an existing structure evaluation, structures shall be modelled as close to the actual as-built structural conditions as possible. The correct choice of modelling and analysis tools/methods depends on:

a) Importance of the structure
b) Purpose of structural analysis
c) Required level of response accuracy

This section will present modelling guidelines and techniques for bridge structures.

MATHEMATICAL MODELLING AND CALCULATIONS

A bridge structure is discretized with finite-size elements. Element characteristics are derived from the constituent structural materials. Figure 1 shows the levels of modelling for seismic analysis of bridge structures.

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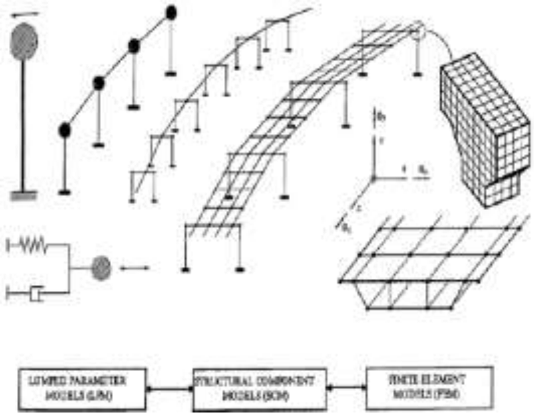


Fig:1 Seismic analysis of bridge structures.

Frame Models

A frame model is a portion of structure between the expansion joints. It is a powerful tool to assess the true dynamic response of the bridge since dynamic response of stand-alone bridge frames can be assessed with reasonable accuracy as an upper bound response to the whole structure system. Seismic characteristics of individual frame responses are controlled by mass of superstructure and stiffness of individual frames. Transverse stand-alone frame models shall assume lumped mass at the columns. Hinge spans shall be modelled as rigid elements with half of their mass lumped at the adjacent column.

Superstructures

For modelling slab-beam bridges, either Spine Model or a Grillage Model should be used.

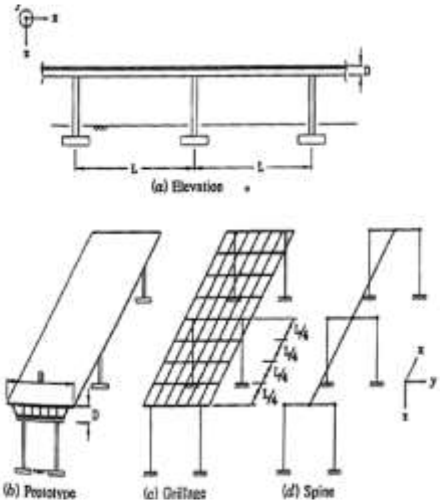
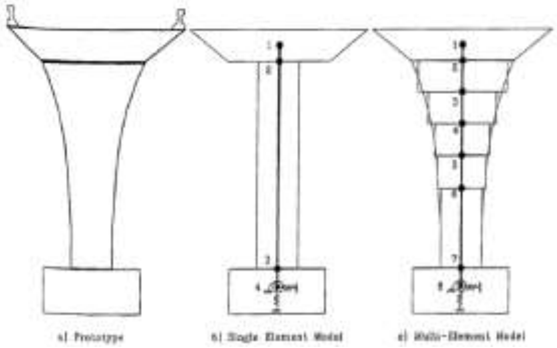


Fig:2 flyover based structures with frames

Bents

If the bridge superstructure can be assumed to move as a rigid body under seismic load, the analysis can be simplified to modelling bents only. Frame elements, effective bending stiffness, cap with large torsion and transverse bending stiffness to capture superstructure, and effective stiffness for outriggers should be considered.



CALCULATIONS

The total span of the flyover is divided mainly into three sections: (1) First trestle portion with 9 spans of each of 22.20m (2) Middle obligatory span of 35m (3) Second trestle portion with 8 spans each of 21.50m .A minimum vertical clearance of 6.00m is allotted for the obligatory span. Flyover has been designed as bi-directional (each two lane) with a design speed of 85kmph. Cast-in-situ RC girder and deck slab of grade M35 concrete is being used for the standard spans (the two trestle portions), whereas cast-in-situ pre-stressed concrete post tensioned girders and deck slab of grade M40 is being used for the obligatory span. Grade of concrete used for the sub structural components like pier, pier cap, and piles is M35. All the necessary reinforcement is provided using Fe500 confirming to IS: 1786. A solid ramp portion with slope of 1in 30 is provided on either sides of the flyover. An initial valley curve (100.00m), followed by a 1 in 30 slope (116.40m), a summit curve (280.00m), another 1 in 30 slope (135.441m), another valley curve (100.00m), and a 1 in 150.37m slope together comprises the entire section of flyover. Elastomeric bearings separate the superstructure from substructure.

DESCRIPTION OF THE MATERIALS

Concrete Concrete of grade M35 is adopted in the design of RC deck slab and isolated footing.
Steel Steel of grade Fe 415 is adopted for the reinforcement and E250 Steel is adopted for the girder design.

LOADS ON THE STRUCTURE

Dead Loads: The dead loads of the structure consists of the self-weight of the various components such as deck slab, intermediate girders, cross girders, crash barriers, hand rails, wearing coat. • D.L due to self-weight of the structure which is incorporated by SAP software • D.L due to crash barriers and hand rails = 7.5 kN/m
• D.L due to wearing coat = 1.76kN/m2

Live Loads: In SAP, the bridge loads can be assigned in the form of moving loads and impact loads. IRC: 6-2014 is used to verify all values. The governing loading types are:

i. Class AA wheeled type vehicle
ii. Class AA Tracked type vehicle

Vehicles : Vehicles are defined for Class AA wheeled and tracked in accordance to IRC 6, 2014

METHODOLOGY OF SIMULATIONS

STEPS INVOLVED IN STAAD :

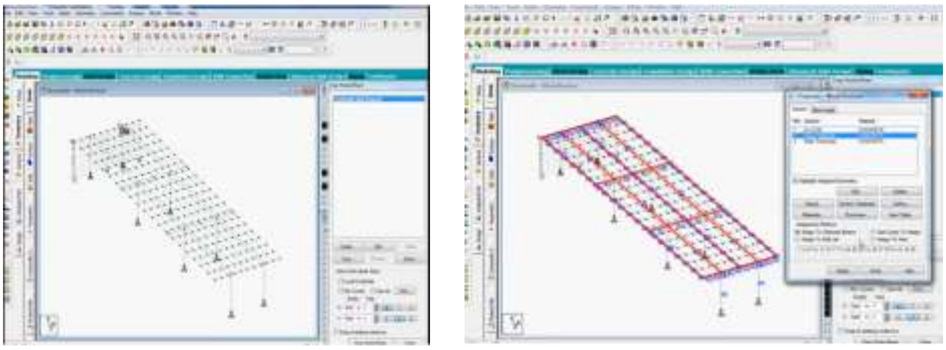


Fig3: Node points for deck preparation

Material Property

The material property considered for the present pier analysis for concrete and reinforcement steel are given in Table 1.

S.NO	Name	E (KN/mm^2)	v	Density (kg/m^3)	
1	Steel	205.000	0.300	7.83E+3	12E -6
2	Stainlesssteel	197.930	0.300	7.83E+3	18E -6
3	Aluminum	68.948	0.330	2.71E+3	23E -6
4	Concrete	21.718	0.170	2.4E+3	10E -6

Table 1: Material Properties

Structure types

Number of Nodes	1728	Highest Node	1728
Number of Elements	590	Highest Beam	2188

Load cases

Number of Basic Load Cases	3
Number of Combination Load Cases	0

Type	L/C	Name
Primary	1	DL
Primary	2	IRC : ULS CLASS LOADING N21
Primary	3	IRC : ULS CLASS LOADING N166

Section properties

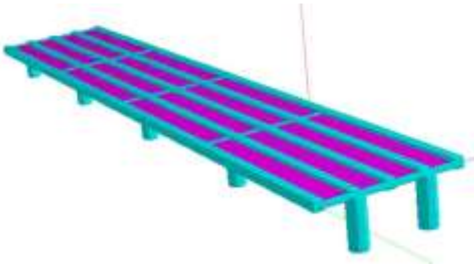
prop	section	Area(cm^2)	I_{YY}(cm^2)	I_{XX}(cm^2)	J(cm^2)	Material
6	Clr 2.00	31.4E+3	78.5E+6	785E+6	157E+6	CONCRETE
7	Rect 1.00*1.00	10E+3	8.33E+6	8.33E+6	14.1E+6	CONCRETE
8	Rect 1.00*1.00	10E+3	8.33E+6	8.33E+6	14.1E+6	CONCRETE
9	Rect 0.50*0.50	2.5E+3	521E+3	521E+3	879E+3	CONCRETE

Plate Thickness

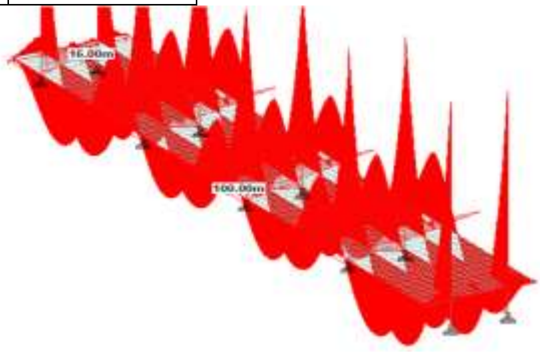
prop	Node A (cm)	Node B (cm)	Node C (cm)	Node D (cm)	Material
1	30.000	30.000	30.000	30.000	CONCRETE
2	30.000	30.000	30.000	30.000	CONCRETE
3	30.000	30.000	30.000	30.000	CONCRETE
4	30.000	30.000	30.000	30.000	CONCRETE
5	30.000	30.000	30.000	30.000	CONCRETE

Self-weight: 1 DL

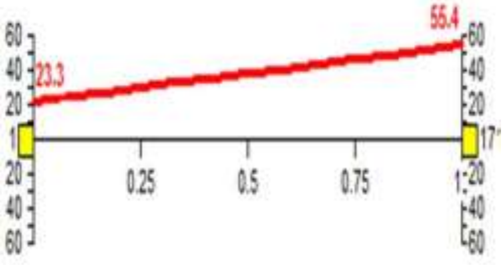
Direction	Factor
Y	-1.000



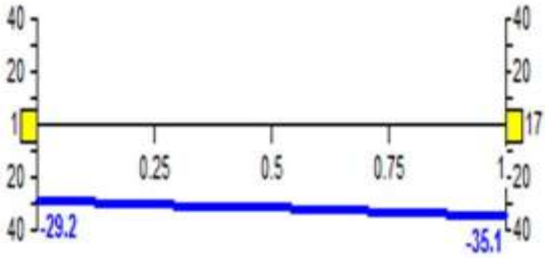
3D Rendering View



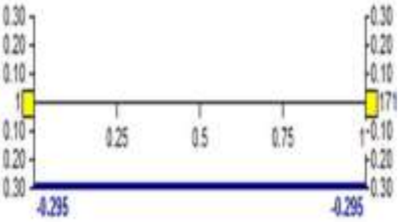
Bending Z



Mz(kNm) Beam Graph



Fy(kN) Beam Graph



Fx(kN) Beam Graph

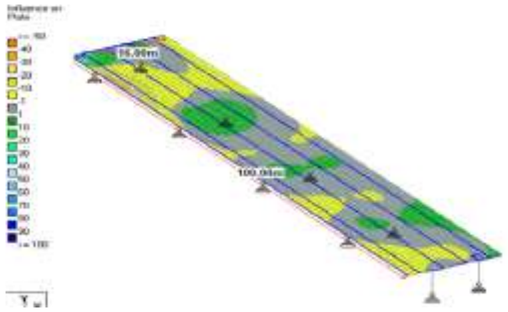


Plate Stresses

RESULTS AND DISCUSSIONS

The output data for the IRC Class 70R bogie loadings are considered which include nodal displacement, nodal displacement summary, beam forces, beam end displacements, beam end displacement summary, reactions, reaction summary, axial forces, beam moments, live load effect and many more by STAAD. Pro V8i. As all of them cannot be described in this project, the data result tables being very large, some of the glimpse of the output results in the tabular forms is provided in this below

Tabular-result

Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	52	2:IRC:ULS CLA	3.707	0.172	-1.084	3.866	0.001	-0.000	0.000
Min X	2	2:IRC:ULS CLA	-6.141	-0.079	-1.794	6.398	-.001	-0.000	0.001

Max Y	5	2:IRC:ULS CLA	-6.102	3.665	-0.404	7.129	-0.00	-0.000	0.001
Min Y	1529	1: DL	0.015	-51.20	-0.287	51.204	-0.00	0.000	-.005

Beam displacement detail summary

	Beam	L/C	d(m)	X(mm)	Y(mm)	Z(mm)	Resultant(mm)
Max X	68	2:IRC:ULS CLA	0.100	3.707	0.193	-1.077	3.866
Min X	2	2:IRC:ULS CLA	0.000	-6.141	-0.079	-1.794	6.398
Max Y	9	2:IRC:ULS CLA	0.000	-6.102	3.665	-0.404	7.129
Min Y	334	1: DL	0.000	0.014	-51.205	-0.289	51.206
Max Z	40	3:IRC:ULS CLA	0.000	0.129	-0.062	1.135	1.144
Min Z	1	2:IRC:ULS CLA	0.000	-6.126	-20.562	-2.212	21.569
MaxRst	334	1: DL	0.900	0.014	-51.205	0.289	51.206

Beam end displacement summary

	Beam	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	39	52	2:IRC:ULS CLA	3.707	0.172	-1.085	3.866
Min X	2	2	2:IRC:ULS CLA	-6.141	-0.079	-1.794	6.398
Max Y	9	5	2:IRC:ULS CLA	-6.102	3.665	-0.404	7.129
Min Y	1930	1529	1: DL	0.014	-51.203	-0.287	51.204
Max Z	40	24	3:IRC:ULS CLA	0.129	-0.062	1.135	1.144
Min Z	1	1	2:IRC:ULS CLA	-6.126	-20.562	-2.212	21.569
Max Rst	1930	1529	1: DL	0.014	-51.203	0.287	51.204

Beam maximum forces by section property

		axial	shear		Torsion	Bending	
section		Max Fx (kN)	Max Fy (kN)	Max Fz (kN)	Max Mx (kN)	Max My (kN)	Max Mz (kN)
Clr 2.00	Max+ve	3.4E+3	371.059	869.892	0.000	4.35E+3	1.86E+3
	Max-ve	-109.032	-371.059	-869.892	0.000	-4.35E+3	-1.86E+3
Rect 1.00*1.00	Max+ve	584.572	1.3E+3	49.518	583.174	41.139	3.98E+3
	Max-ve	-135.926	-1.3E+3	-49.518	583.174	-41.139	-1.48E+3

Plate centre principal stress summary

			principle		Von mis		Tresca	
	plate	L/C	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)
Max	589	1 :DL	-9.113	17.125	15.024	14.832	17.341	17.125
Max	589	1 :DL	-9.113	17.125	15.024	14.832	17.341	17.125
Max VM	589	1 :DL	-9.113	17.125	15.024	14.832	17.341	17.125
Max VM	589	1 :DL	-9.113	17.125	15.024	14.832	17.341	17.125

Reaction summary

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	29	1: DL	371.059	3.4E+3	103.452	0.000	0.000	0.000
Min FX	28	1: DL	-371.059	3.4E+3	103.452	0.000	0.000	0.000
Max FY	29	1: DL	371.059	3.4E+3	103.452	0.000	0.000	0.000
Min FY	29	2:IRC:ULS CLA	64.323	-109.032	53.277	0.000	0.000	0.000
Max FZ	35	1: DL	176.342	1.77E+3	869.892	0.000	0.000	0.000

Base Pressure Summary

	Beam	L/C	FX (N/mm^2)	FY (N/mm^2)	FZ (N/mm^2)
Max FX	26	1: DL	0.000	0.000	0.000
Min FX	26	1: DL	0.000	0.000	0.000
Max FY	26	1: DL	0.000	0.000	0.000
Min FY	26	1: DL	0.000	0.000	0.000
Max FZ	26	1: DL	0.000	0.000	0.000
Min FZ	26	1: DL	0.000	0.000	0.000

CONCLUSIONS

Construction of fly overs using R.C.C is time consuming, and will affect existing traffic. Construction of fly overs using steel sections can overcome these disadvantages, even though its initial cost is high. Steel bridges offer wide range of solutions to choose from based on the design/site requirements. Truss type or girder type, deck type or through type, arch type or frame type, simple or continuous span type, all-steel or composite construction options are only a few examples.

1.The maximum resultant nodal displacement is for node 1529; 0..015mm in x, -51.203mm in y and -.287mm in x.

2.The maximum resultant beam end displacement is for beam 1930 and node 1529 equivalent to 51.204.

3. The maximum and minimum values for beam maximum forces by section property are computed for axial, shear and bending.

4.The effect of vertical loading for 6 traffic lanes showing width, front clearance, rear clearance, no. of axles, positon in x, position in y with orientation can be determined. The orientation varies from 0 to 1.5708.

5.The concrete design for element 61 gives the top and bottom longitudinal reinforcement is 0.540 and 0.545. The top and bottom transverse reinforcement are 0.540 and 0.780 for element 61. Similarly, for other element, it can be found out.

6. It is must for today's engineers, designers, research scholars to make an effective contribution to what is the purpose of each high quality design and for the improvement of quality of environment in which we all are residing. Thus evolution of software must be properly used so that it meets the beneficiary needs.

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