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COMPARATIVE STUDY OF EFFECT OF VARYING SPAN LENGTH ON MAJOR ELEMENTS OF METRO BRIDGE

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1. ABSTRACT: A metro system is a railway transport system in an urban area with a high capacity, frequency and the grade separation from other traffic. Metro System is used in cities, agglomerations, and metropolitan areas to transport large numbers of people. An elevated metro system is more preferred type of metro system due to ease of construction and also it makes urban areas more accessible without any construction difficulty. An elevated metro system has two major elements pier and girder.

In this study we have focused on two curve models of total span of 100 meter. The main focus in this comparative study is to find a suitable design for the metro system because for varying design systems we will face construction issues as well as traffic planning issues. Models of different span of 40 and 70 meter is analysed here just to find out a significant span so that we can generalize the complete metro design from a single analysis it will help us in both construction of metro rail and road traffic planning as well

Keywords: Metro Structure, Bridge Pier, Girder Bridge, Seismic Design, Pier Design, Curved Model

2. INTRODUCTION

A metro system is an electric passenger railway transport system in an urban area with a high capacity, frequency and the grade separation from other traffic. Metro System is used in cities, agglomerations, and metropolitan areas to transport large numbers of people at high frequency. The grade separation allows the metro to move freely, with fewer interruptions and at higher overall speeds. Metro systems are typically located in underground tunnels, elevated viaducts above street level or grade separated at ground level. An elevated metro structural system is more preferred one due to ease of construction and also it makes urban areas more accessible without any construction difficulty. An elevated metro structural system has the advantage that it is more economic than an underground metro system and the construction time is much shorter. An elevated metro system has two major components pier and girder. A typical elevated metro bridge model. Viaduct or girder of a metro bridge requires pier to support the each span of the bridge and station structures. Piers are constructed in various cross sectional shapes like cylindrical, elliptical, square, rectangular and other forms. The piers considered for the present study are in rectangular cross section and it is located under station structure. A typical girders and pier considered for the present study. In the present study we are compare the two models and analysed their results for future planning.

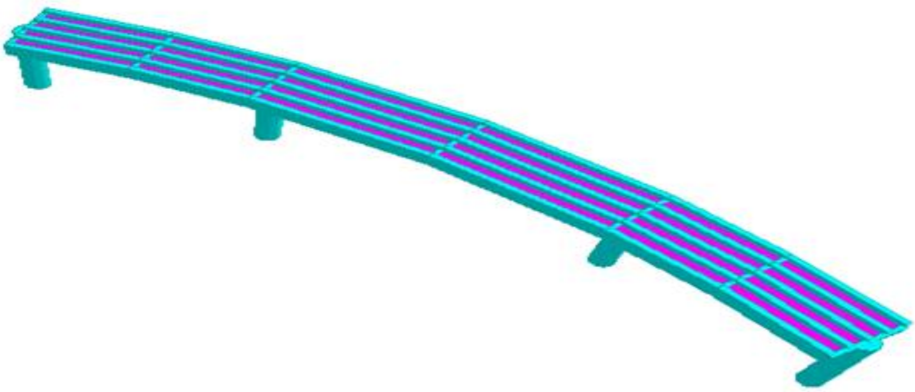

Figure 1 Curved Bridge Model

GENRAL CRITERIA:

Genral criteria used for the design purpose is given below:

CAPACITY
DMC: Driving Trailer Car
MC: Motor Car
Tc: Trailer Car
6 Car Train Composition: DMC + TC + MC + MC + TC + DMC
DMC: 247 Passenger (Sitting-43, Crush Standing-204)
TC/MC: 270 Passeneger (Sitting–50, Crush Standing-220)
6 Car Train: 1574 Passenger (Sitting-286, Crush Standing-1288)

IS CODE USING:

- IS 1893
- IS 875-I
- IS 875-II
- IS 456:2000
- IRC Boggie Load
- IS 13920

BRIDGE DETAILS:

- Total Length of bridge : 100 m
- Length of End Span : 15 m (in model 1) & 30 m (in model 2)
- Length of mid span : 70 m (in model 1) & 40 m (in model 2)
- Bridge design for : 20 T /m
- Overall design for loading : 200 T
- Bridge Design for Maximum Speed : 95 kmph
- Width of gauge / carriageway = 1435 mm

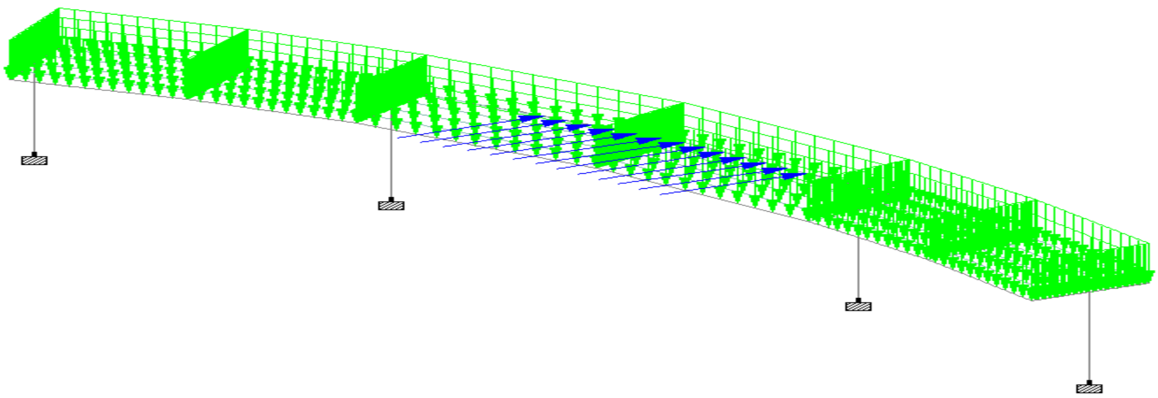

Fig 2- Forces On Curve Model

3. LITERATURE REVIEW

Kuppumanikandan A (2013), parametic studies on major element of an elevated metro bridge, Department of Structural engineering, Nit Rourkela

Kees Vanamölder (MAY,2017) conducted study in order to evaluate possible structural solutions for bridges in practical case, case-study was performed on the basis of designed Rail Baltic bridge over Pärnu river. Rail Baltic is designed as new railway line between Tallinn and Poland that would connect Baltic states with European railway network with 1435 mm track gauge. Rail Baltic is double-track electrified railway line for mixed traffic with design speed of 240 km/h and with overall length around 700 km. In Estonia overall length of railway route is around 210 km and railway alignment follows Tallinn (Muuga/Ülemiste), Rapla, Pärnu and Ikla. The conclusion was made that since LCC of arch, network arch and truss bridges occurred to be similar, these structural forms can be considered as the most suitable for span 170 m from the financial point of view. LCC of suspension and cable-stayed bridges are approximately 2-3 times

4. OBJECTIVE

- The aim of the study is to find a suitable design at a location where total span length is 100 m and Radius of Curvature is 150 m and the traffic design as well as other construction issues is based on the Mid Span of Bridge.
- The main focus in this comparative study is to find a suitable design for the metro system as well as traffic planning issues at that location .So the Models of two different mid span of 40 and 70 metre is analysed here just to find out a significant span so that we can generalize the metro design as well as traffic planning from a single analysis it will help us in both construction of metro rail and road traffic planning at that location.
- In this comparative study, two curved models of radius 150 m have been considered of total span 100 m. In the first model, the mid span between piers is 70 m & side span is 15 m each. In the second model, the mid span between piers is 40m & side span is 30 m each.
- The objective is to give a thought regarding the examination and plan of metro Bridge. Here the model is being outlined according to IRC70R stacking and all the necessary loads they used In metro Bridge which is appropriate on all streets on which the changeless extensions and ducts can be built. Investigation and Design process by Staad Pro decides the execution of structures.
- In this we can genralised the significant span between two curve model length 40m and 70m this study case is also use full for future uses for this type of case..

5. METHEDOLOGY

- A girder bridge, in general, is a bridge that uses girders as the means of supporting the deck. A bridge consists of three parts: the foundation (abutments and piers), the superstructure (girder, truss, or arch), and the deck. A girder bridge is very likely the most commonly built and utilized bridge in the world. Its basic design, in the most simplified form, can be compared to a log ranging from one side to the other across a river or creek. In modern girder stee bridges, the two most common shapes are plate girders and box girders. The term "girder" is often used interchangeably with "beam" in reference to bridge design.
- STAAD. Pro. in space is Operated with units Metre and Kilo Newton. The geometry is drawn and the section properties are assigned. Fixed Supports are taken. Quadrilateral meshing is done followed by assigning of plate thickness.3D rendering can be viewed for the geometry. Loads are defined by the loads and definitions. By Post Processing mode, Noda displacement, Max. Absolute Stress distribution for the bridge can be viewed. Run analysis is operated. Max. Response by the IRC Class 70R loading is done by STAAD.beava. The deck is created in bridge deck processor, this being the first step of STAAD.beava. In STAAD.beava, roadways, curbs, vehicular parameters are provided. Lastly transfer of load is done into STAAD Pro. For further analysis and design. Al the Max response criteria are checked Mx,My,Mz stresses etc for different members elements. The load positions and reactions, beam forces and moments, etc. are determined. The concrete is designed as per IS Code.

5.1. METHOD USED FOR ANALAYSIS

The Finite Element Method is used for analysis Beam and Coloum Design and the steps used for analysis they are following as:

Step-1 Calculation Loads

Wu = F.O.S x W

Where, Wu = Factored Load

W = Total Load

Step 2 Calculation Maximum Bending Moment

Mu = Wu x Leff^2

Where, Mu = Maximum Bending Moment

Step 3 Calculation Effective Depth

Deff = √Mu/Ru x b

Where, Ru = Grade Of Steel = 0.133fck

Step 4 -Calculation Area Of Steel (Ast)

Area of tension reinforcement (A_{st1}) for a singly reinforced section at mid span and at support is calculated from Annex G-1.1(b) of IS 456:2000

$$A_{st.1} = \frac{0.5 f_{ck}}{f_y}\left(1-\sqrt{1-\left(\frac{4.6 M_u}{f_{ck} b d^2}\right)}\right) bd$$

If section is over reinforced then area of compression reinforcement (A_{sc}) and additional tensile reinforcement (A_{st2}) is calculated from Annex G-1.2 of IS 456:2000

$$M_u - M_{u,lim} = f_{sc} A_{sc} (d - d')$$
$$A_{st2} = A_{sc}\ f_{sc} / 0.87 f_y$$

Step 5 - Calculate Shear Reinforcement

Nominal shear stress in beams is calculated from clause 40.1 of IS 456:2000[9].

$$\tau_v = \frac{V_u}{bd}$$

Where,

τ_v = Nominal shear stress

Step 6-Calculate Minimum percentage of steel

Pt_{min} (%)= 100 x A_{st}/ bd

Step 7- Calculate spacing

Spacing in beam is calculated from clause 26.5.1.5, and 26.5.1.6 of IS 456:2000[9].

$$\frac{A_{sv}}{b s_v} \geq \frac{0.4}{0.87 f_y}$$

Step 8- check for deflection

Fsc =(0.58fy x A_{st} Req) / A_{st} Provided

6. RESULT & DISCUSSION

Parametric Study on Girder Bridge and piers using finite element method and compare the Result of Both Models are described in this chapter.

Two different models of total span 100m but varying pier spans is considered here. The first model has 40m of mid span and 30 m of side spans. The second model has 70m of mid span and 15 m of side spans. Figure as shown below:

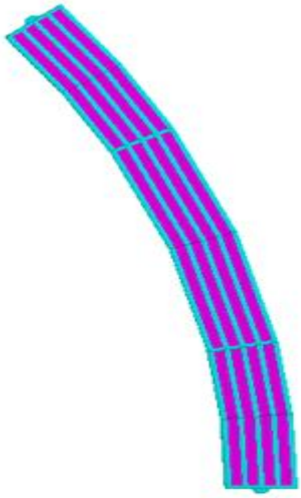

Figure 3 Top View (Mid span 40m)

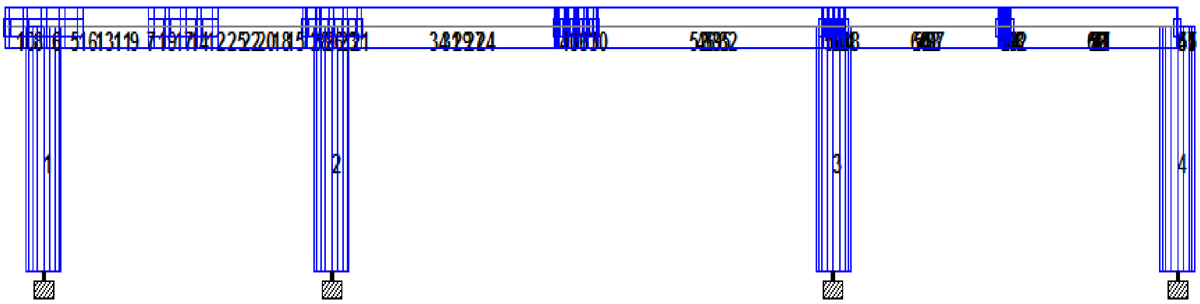

Figure 4 Front View (Mid span 40m)

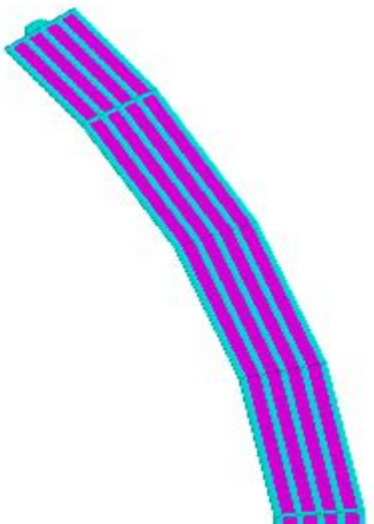

Figure 5 Top View (Mid span 70m)

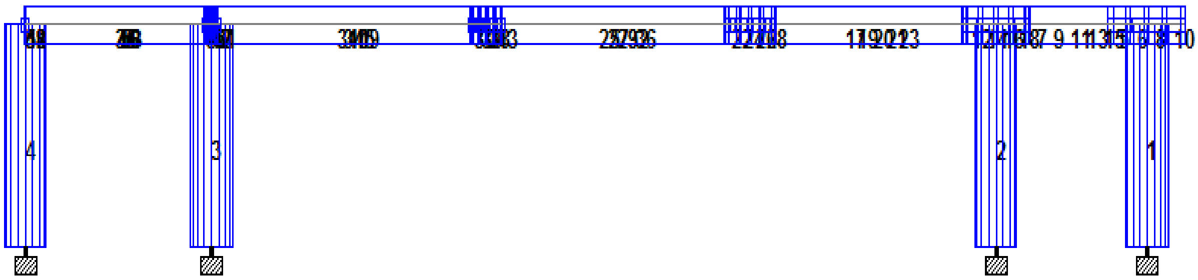

Figure 6Front View (Mid span 70m)

6.1.1. SUPPORT REACTIONS COMPARISON

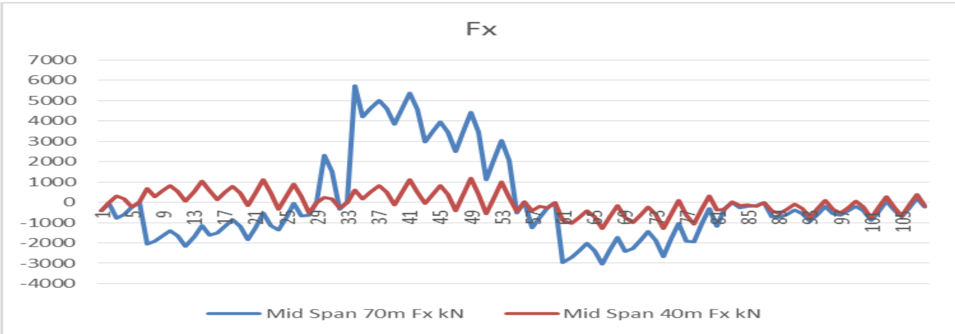

Figure 7 SUPPORT REACTIONS (Fx)

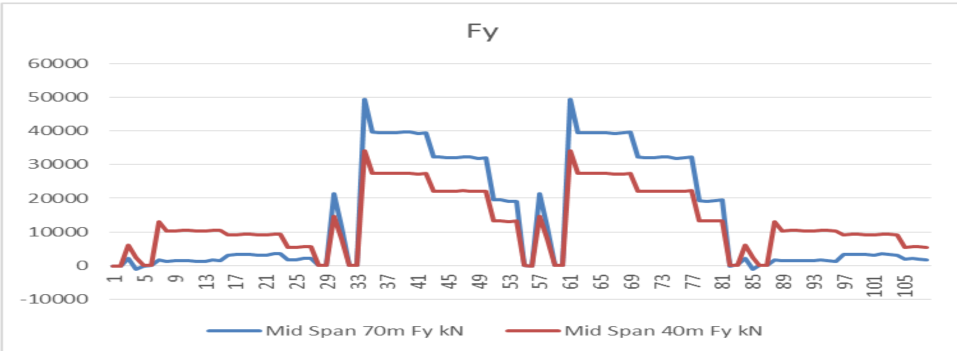

fig 8 SUPPORT REACTIONS (Fy)

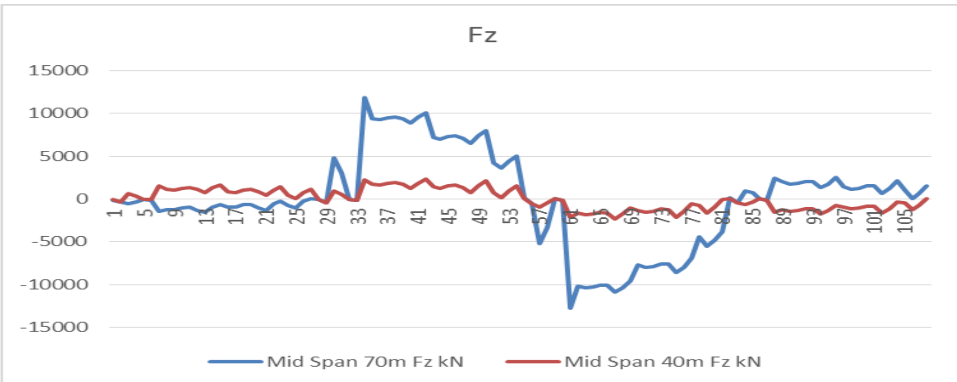

Fig 9 SUPPORT REACTIONS (Fz)

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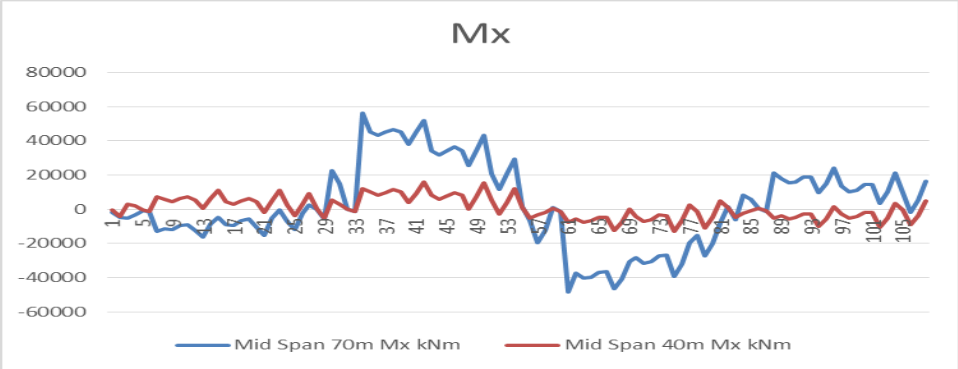

Fig 10 SUPPORT REACTIONS (Mx)

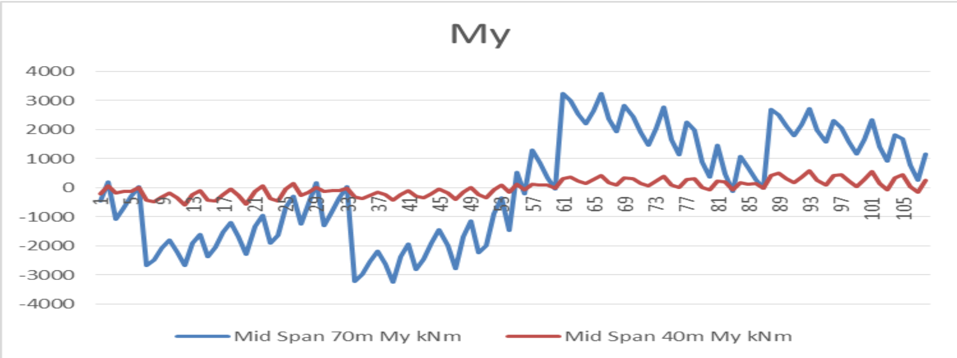

Fig 11 SUPPORT REACTIONS (My)

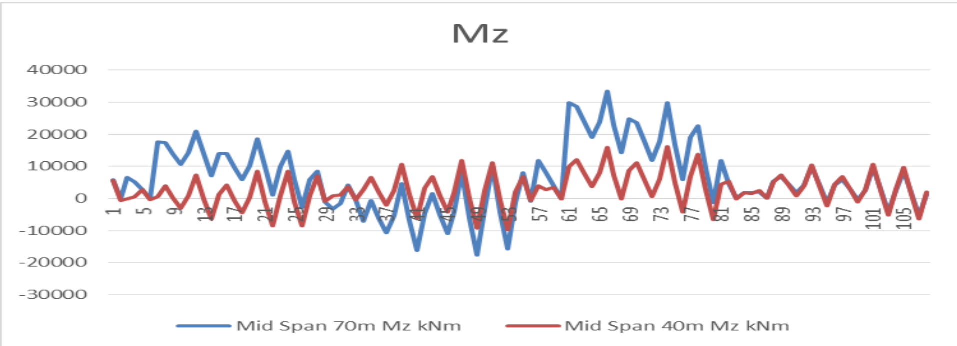

Fig 12 SUPPORT REACTIONS (Mz)

Table 6.1SUPPORT REACTIONS (Fx) of Mid Span 40m

	Node	L/C	Fx kN
Max Fx	2	1.5X(DEAD+LIVE)	620.056
Min Fx	1	EQ+X	-423.889
Max Fx	2	1.2X(DEAD+LIVE-SEISMIC)	506.449
Min Fx	3	1.2X(DEAD+LIVE+SEISMIC)	-715.684
Max Fx	4	1.2X(DEAD+LIVE+SEISMIC)	-739.322
Min Fx	1	1.2X(DEAD+LIVE-SEISMIC)	39.853
Max Fx	2	IRC: SLS Class 70R+A Loading	-1301.55
Min Fx	3	IRC: SLS Class 70R+A Loading	1015.397

Table 6.2 SUPPORT REACTIONS (Fx) of Mid Span 70m

	Node	L/C	Fx kN
Max Fx	2	1.5X(DEAD+LIVE)	5752.268
Min Fx	1	EQ+X	-589.432
Max Fx	2	1.2X(DEAD+LIVE-SEISMIC)	-3023.021
Min Fx	3	1.2X(DEAD+LIVE+SEISMIC)	3840.142
Max Fx	4	1.2X(DEAD+LIVE-SEISMIC)	-3023.021
Min Fx	1	1.2X(DEAD+LIVE-SEISMIC)	3840.142
Max Fx	2	IRC: SLS Class 70R+A Loading	506.449
Min Fx	3	IRC: SLS Class 70R+A Loading	-595.961

NOTE:

- In The Above Comparation we compare the support reaction between 40m span model and 70m span model in horizontal reaction (Fx).
- We found that 40 m span model reaction (Fx) is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used.

Table 6.3 SUPPORT REACTIONS (Fy) of Mid Span 40m

	Node	L/C	Fy kN
Max Fy	2	1.5X(DEAD+LIVE)	34172.23
Min Fy	1	EQ+X	-92.432
Max Fy	2	1.2X(DEAD+LIVE-SEISMIC)	27303.67
Min Fy	3	1.2X(DEAD+LIVE+SEISMIC)	27256.1
Max Fy	4	1.2X(DEAD+LIVE+SEISMIC)	10337.28
Min Fy	1	1.2X(DEAD+LIVE-SEISMIC)	10258.35
Max Fy	2	IRC: SLS Class 70R+A Loading	28323.32
Min Fy	3	IRC: SLS Class 70R+A Loading	22009.85

Table 6.4 SUPPORT REACTIONS (Fy) of Mid Span 70m

	Node	L/C	Fy kN
Max Fy	2	1.5X(DEAD+LIVE)	49368.23
Min Fy	1	EQ+X	-982.638
Max Fy	2	1.2X(DEAD+LIVE-SEISMIC)	39557.61
Min Fy	3	1.2X(DEAD+LIVE+SEISMIC)	-3840.142
Max Fy	4	1.2X(DEAD+LIVE+SEISMIC)	-27307.67
Min Fy	1	1.2X(DEAD+LIVE-SEISMIC)	22009.85
Max Fy	2	IRC: SLS Class 70R+A Loading	5752.268
Min Fy	3	IRC: SLS Class 70R+A Loading	-2966.97

NOTE:

- In The Above Comparation we compare the support reaction between 40m span model and 70m span model in horizontal reaction (Fy).
- We found that 40 m span model reaction (Fy) is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used.

Table 6.5 SUPPORT REACTIONS (Fz) of Mid Span 40m

	Node	L/C	Fz kN
Max Fz	2	1.5X(DEAD+LIVE)	2205.981
Min Fz	1	EQ+X	-86.118
Max Fz	2	1.2X(DEAD+LIVE-SEISMIC)	2321.834
Min Fz	3	1.2X(DEAD+LIVE+SEISMIC)	-2311.3
Max Fz	4	1.2X(DEAD+LIVE+SEISMIC)	-1162.81
Min Fz	1	1.2X(DEAD+LIVE-SEISMIC)	1081.854
Max Fz	2	IRC: SLS Class 70R+A Loading	2341.54
Min Fz	3	IRC: SLS Class 70R+A Loading	-2148.34

Table 6.6 SUPPORT REACTIONS (Fz) of Mid Span 70m

	Node	L/C	Fz kN
Max Fz	2	1.5X(DEAD+LIVE)	11818.081
Min Fz	1	EQ+X	-407.474
Max Fz	2	1.2X(DEAD+LIVE-SEISMIC)	-10083.814
Min Fz	3	1.2X(DEAD+LIVE+SEISMIC)	-9361.517
Max Fz	4	1.2X(DEAD+LIVE+SEISMIC)	-10083.814
Min Fz	1	1.2X(DEAD+LIVE-SEISMIC)	2321.834
Max Fz	2	IRC: SLS Class 70R+A Loading	12798.544
Min Fz	3	IRC: SLS Class 70R+A Loading	-7335.729

NOTE:

- In The Above Comparation we compare the support reaction between 40m span model and 70m span model in horizontal reaction (Fz).
- We found that 40 m span model reaction (Fz) is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used.

Table 6.7 SUPPORT REACTIONS (Mx) of Mid Span 40m

	Node	L/C	Mx kN
Max Mx	2	1.5X(DEAD+LIVE)	12271.43
Min Mx	1	EQ+X	-268.179
Max Mx	2	1.2X(DEAD+LIVE-SEISMIC)	15830.98
Min Mx	3	1.2X(DEAD+LIVE+SEISMIC)	-12476.9
Max Mx	4	1.2X(DEAD+LIVE+SEISMIC)	5562.437
Min Mx	1	1.2X(DEAD+LIVE-SEISMIC)	-2979.86
Max Mx	2	IRC: SLS Class 70R+A Loading	7260.81
Min Mx	3	IRC: SLS Class 70R+A Loading	-3653

Table 6.8 SUPPORT REACTIONS SUMMARY (Mx) of Mid Span 70m

	Node	L/C	Mx kN
Max Mx	2	1.5X(DEAD+LIVE)	56243.6913
Min Mx	1	EQ+X	-3483.057
Max Mx	2	1.2X(DEAD+LIVE-SEISMIC)	56243.691
Min Mx	3	1.2X(DEAD+LIVE+SEISMIC)	45027.945
Max Mx	4	1.2X(DEAD+LIVE+SEISMIC)	36547.637
Min Mx	1	1.2X(DEAD+LIVE-SEISMIC)	-15840.98
Max Mx	2	IRC: SLS Class 70R+A Loading	48209.133
Min Mx	3	IRC: SLS Class 70R+A Loading	-36483.057

NOTE:

- In The Above Comparation we compare the support reaction between 40m span model and 70m span model in horizontal reaction (Mx).
- We found that 40 m span model reaction (Mx) is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used.

Table 6.9 SUPPORT REACTIONS (My) of Mid Span 40m

	Node	L/C	My kN
Max My	2	1.5X(DEAD+LIVE)	384.358
Min My	1	EQ+X	-202.03
Max My	2	1.2X(DEAD+LIVE-SEISMIC)	288.172
Min My	3	1.2X(DEAD+LIVE+SEISMIC)	--172.547
Max My	4	1.2X(DEAD+LIVE+SEISMIC)	583.653
Min My	1	1.2X(DEAD+LIVE-SEISMIC)	-578.359
Max My	2	IRC: SLS Class 70R+A Loading	506.449
Min My	3	IRC: SLS Class 70R+A Loading	-595.961

Table 6.10 SUPPORT REACTIONS (My) of Mid Span 70m

	Node	L/C	My kN
Max My	2	1.5X(DEAD+LIVE)	-3228.809
Min My	1	EQ+X	-707.364
Max My	2	1.2X(DEAD+LIVE-SEISMIC)	3248.856
Min My	3	1.2X(DEAD+LIVE+SEISMIC)	-3239.552
Max My	4	1.2X(DEAD+LIVE+SEISMIC)	3243.753
Min My	1	1.2X(DEAD+LIVE-SEISMIC)	-3248.856
Max My	2	IRC: SLS Class 70R+A Loading	5056.449
Min My	3	IRC: SLS Class 70R+A Loading	-4595.961

NOTE:

- In The Above Comparation we compare the support reaction between 40m span model and 70m span model in horizontal reaction (My).
- We found that 40 m span model reaction (My) is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used.

Table 6.11 SUPPORT REACTIONS (Mz) of Mid Span 40m

	Node	L/C	Mz kN
Max Mz	2	1.5X(DEAD+LIVE)	2823.933
Min Mz	1	EQ+X	-5658.78
Max Mz	2	1.2X(DEAD+LIVE-SEISMIC)	3223.773
Min Mz	3	1.2X(DEAD+LIVE+SEISMIC)	-7175.684
Max Mz	4	1.2X(DEAD+LIVE+SEISMIC)	10453.57
Min Mz	1	1.2X(DEAD+LIVE-SEISMIC)	-7313.98
Max Mz	2	IRC: SLS Class 70R+A Loading	9676.76
Min Mz	3	IRC: SLS Class 70R+A Loading	-6434.65

Table 6.12 SUPPORT REACTIONS (Mz) of Mid Span 70m

	Node	L/C	Mz kN
Max Mz	2	1.5X(DEAD+LIVE)	7174.72
Min Mz	1	EQ+X	-5102.659

Max Mz	2	1.2X(DEAD+LIVE-SEISMIC)	33486.26
Min Mz	3	1.2X(DEAD+LIVE+SEISMIC)	-4585.659
Max Mz	4	1.2X(DEAD+LIVE+SEISMIC)	3223.77
Min Mz	1	1.2X(DEAD+LIVE-SEISMIC)	-5030.74
Max Mz	2	IRC: SLS Class 70R+A Loading	5666.449
Min Mz	3	IRC: SLS Class 70R+A Loading	-5435.961

NOTE:

- In The Above Comparation we compare the support reaction between 40m span model and 70m span model in horizontal reaction (Mz).
- We found that 40 m span model reaction (Mz) is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used.

6.1.2 BEAM MAXIMUM STRESSES

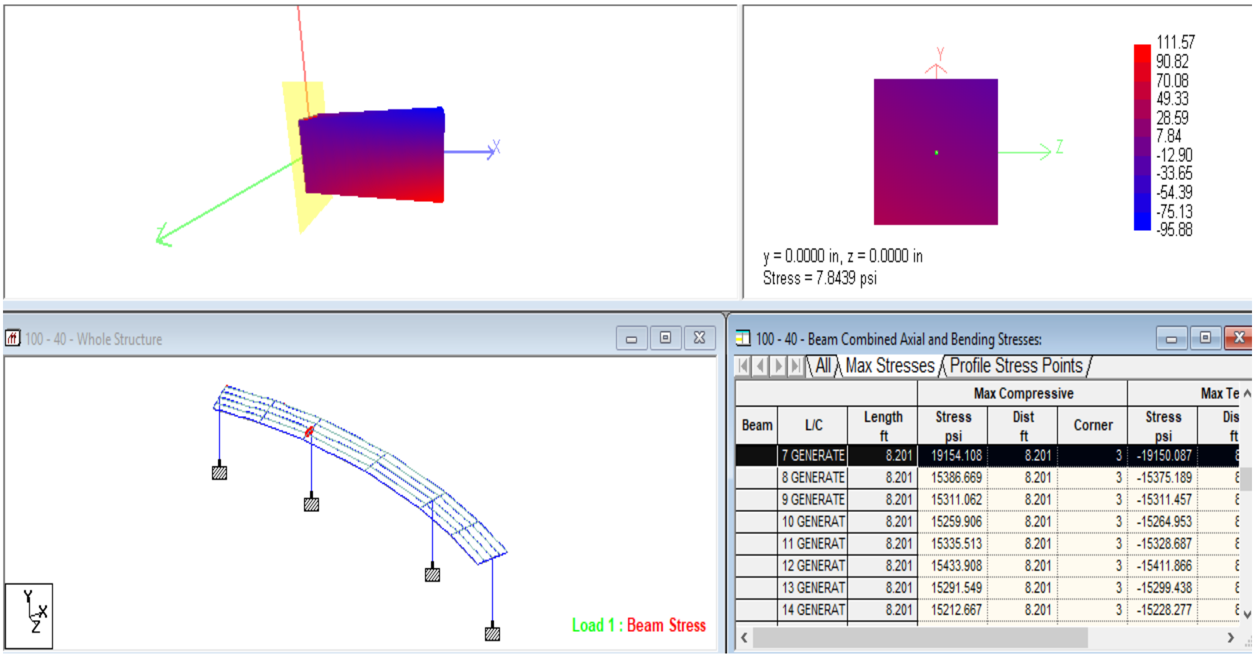

Fig 13-Beam Stresses

Table 6.13 Max Beam Forces Summary of Mid Span 70m

Beam	L/C	Node	Fx kN	Fy kN	Fz Kn	Mx kNm	My kNm	Mz kNm
2	1.5X(DEAD+LIVE)	2	49368.23	-5752.268	-11818.081	-3228.809	-56243.691	7174.707
1	1.5X(DEAD+LIVE)	7	-4067.22	2067.563	1413.352	-2673.605	-8137.466	13479.12
47	1.2X(DEAD+LIVE+SEISMIC)	28	380.371	12102.346	-137.213	1657.892	190.19	27759.94
20	1.2X(DEAD+LIVE-SEISMIC)	12	2218.485	-6616.18	6.231	2920.781	66.232	89864.06
3	IRC: SLS Class 70R+A	28	43510.58	2966.097	12798.544	3243.753	-1.44E+05	14670.84

	Loading							
2	IRC: SLS Class 70R+A Loading	12	43513.06	-5752.268	-11818.081	-3228.809	1.21E+05	-79109.3

Table 6.14 Beam Forces Summary of Mid Span 40m

Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
2	1.5X(DEAD+LIVE)	2	34172.23	-620.056	-2205.98	-322.826	-12271.4	-2823.93
52	1.5X(DEAD+SEISMIC)	36	-449.732	1420.408	-0.47	296.647	-1.808	10347.93
50	1.2X(DEAD+LIVE+SEISMIC)	30	18.839	8027.5	-17.295	363.479	23.552	19855.61
44	1.2X(DEAD+LIVE-SEISMIC)	30	8.969	-4572.41	13.185	-128.996	16.941	14288.58
22	IRC: SLS Class 70R+A Loading	18	76.489	2475.063	0.341	1961.127	-5.634	22888.09
55	IRC: SLS Class 70R+A Loading	35	76.615	-1473.29	-0.358	-1961.36	-0.35	-6943.67

NOTE:

- In The Above Comparation we compare the support maximum stresses on Beam between 40m span model and 70m span model).
- We found that 40 m span models Beam stresses is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used

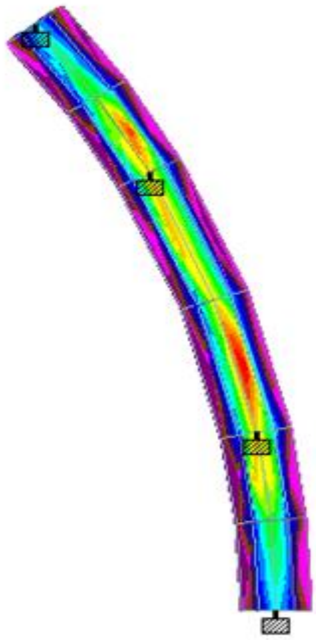

Figure 14 Plate Stresses Mid Span 40m

6.1.3 PLATE MAXIMUM STRESSES

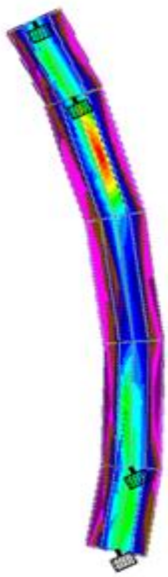

Figure15 Plate Stresses Mid Span 70m

6.1.4 PLATES MAXIMUM STRESSES

Table 4.15 Plate Stressess Summary of Mid Span 70m

		Shear		Membrane			Bending Moment		
Plate	L/C	SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm2	Mx kNm/m	My kNm/m	Mxy kNm/m
60	1.5X(DEAD+LIVE)	-1.317	-1.639	0.155	-0.72	0.326	536.328	132.724	93.064
68	EQ+X	0.007	-0.001	0.033	0.06	-0.121	-0.628	-0.095	0.394
65	1.2X(DEAD+LIVE +SEISMIC)	0.125	0.01	0.024	0.574	-0.02	68.046	-52.637	9.487
60	1.5X(DEAD+LIVE)	-1.317	-1.639	0.155	-0.72	0.326	536.328	132.724	93.064
68	IRC: SLS Class 70R+A Loading	-1.56	1.413	0.204	-0.772	0.001	271.833	76.935	-45.482
55	IRC: SLS Class 70R+A Loading	-0.235	0.316	-0.417	0.467	0.526	340.567	70.769	-16.263

Table 4.16 Plate Stressess Summary of Mid Span 40m

		Shear		Membran e			Bending Moment		
Plate	L/C	SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm2	Mx kNm/m	My kNm/m	Mxy kNm/ m
72	1.5X(DEAD+LI VE)	0.849	-0.518	-0.056	-0.389	0.239	210.018	35.271	19.032
73	1 EQ+X	-0.001	-0.001	-0.001	0.053	0.047	-0.67	0.106	0.031
85	1.2X(DEAD+LI VE+SEISMIC)	-0.242	0.111	0.054	-0.098	-0.081	145.676	19.405	-0.94
75	1.5X(DEAD+LI VE)	0.267	0.273	-0.005	-0.584	-0.084	59.5	-0.135	-9.789
73	IRC: SLS Class 70R+A Loading	-0.471	-0.69	0.018	-0.246	0.031	364.26	59.457	21.934

81	IRC: SLS Class 70R+A Loading	-0.313	-0.37	-0.023	-0.043	0.008	330.011	63.13	-6.191

NOTE:

- In The Above Comparation we compare the Plate Maximum stress between 40m span model and 70m span model.
- We found that 40 m span model plae stresses result is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used**.**

6.1.5 NODES MAXIMUM DISPLACEMENT

Table 4.17 Node Displacement Summary of Mid Span 70m

		Horizontal	Vertical	Horizontal	Resultant	Rotational		
Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
15	EQ+X	2.891	1.095	-0.922	3.226	0	0	0
24	1.5X(DEAD+LIVE)	17.599	-822.939	-5.738	823.147	-0.035	0	-0.037
22	1.2X(DEAD+LIVE+SEISMIC)	4.326	-24.306	6.174	25.448	0.007	0	0.006
29	1.5X(DEAD+LIVE)	9.096	-143.095	-2.511	143.406	-0.003	0	-0.034
5	IRC: SLS Class 70R+A Loading	11.414	-100.528	0.978	101.178	0.021	0	0.014
22	IRC: SLS Class 70R+A Loading	17.599	-822.939	-5.738	823.147	-0.035	0	-0.037

Table 4.18 Node Displacement Summary of Mid Span 40m

		Horizontal	Vertical	Horizontal	Resultant	Rotational		
Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
20	EQ+X	5.912	2.535	-1.099	6.526	0	0	0
20	1.5X(DEAD+LIVE)	8.369	-205.391	-2.955	205.583	-0.006	0	-0.018
23	1.2X(DEAD+LIVE+SEISMIC)	9.279	-40.567	-1.094	41.629	-0.005	0	-0.01
28	1.5X(DEAD+LIVE)	7.2	-78.075	-3.324	78.477	0.001	0	0.018
5	IRC: SLS Class 70R+A Loading	7.692	-78.071	-1.934	78.473	0.011	0	0.015
23	IRC: SLS Class 70R+A Loading	7.333	-104.017	-2.613	104.308	-0.008	0	-0.022

NOTE:

- In The Above Comparation we compare the Nodes maximum Displacement on 40m span model and 70m span model).
- We found that 40 m span models Nodes maximum Displacement is very low compare to 70 m span so we suggested that 40 m span model is suitable for the used

6.2 CONCLUSIONS

In this comparative study we are analyzing curve girder bridge of Total span length is 100 m in which mid span 70m(model 1) and 40 m(model 2) with end span of 15 m(model 1) and 30 m(model 2) respectively and in which we are concluded that since the 40 m span curve bridge stability is more and it is cost effective in comparation with 70 m span curve girder Bridge now following comparative analysis has been shown below.

- **COMPARE TOTAL REINFORCEMENTOF BEAMS IN 40 M & 70 M SPAN MODEL**

SPAN	REINFORCEMENT	RATIO
40	1080.00 QTL	**0.663**
70	1629.32 QTL	

Here it is observed that the variation in Total Reinforcement of Beams in 40 m & 70 m span model is 66% . so we can suggested that 40 m span model is suitable for design and construction as well traffic planning issues also the 40 m span model is economical as compare to 70 m span model.

- **COMPARE TOTAL REINFORCEMENT OF PIERS IN 40 M & 70 M SPAN MODEL**

SPAN	REINFORCEMENT	RATIO
40	229.05 QTL	**0.336**
70	681.89 QTL	

Here it is observed that the variation in Total Reinforcement of piers in 40 m & 70 m span model is 33% . so we can suggested that 40 m span model is suitable for design and construction as well traffic planning issues also the 40 m span model is economical as compare to 70 m span model.

- **COMPARE TOTAL CONCRETE QUANTITY IN 40 M & 70 M SPAN MODEL**

SPAN	CONCRETE	RATIO
40	540.00 CU.METER	**0.677**
70	798.47 CU.METER	

Here it is observed that the variation in Total Concrete Quantity in 40 m & 70 m span model is 67% . so we can suggested that 40 m span model is suitable for design and construction as well traffic planning issues also the 40 m span model is economical as compare to 70 m span model.

- **MAXIMUM SUPPORT REACTION COMPARE BETWEEN 40 M & 70 M SPAN MODEL**

SPAN	Fx(kN)	Fy(kN)	Fz(kN)	Mx(kNm)	My(kNm)	Mz(kNm)	RATIO
40M	1015.39	34172.93	2341.54	12271.43	506.449	10453.57	**0.513**
70M	5752	49368.23	12798.544	56243.61	5056.449	33486.26	

Here it is observed that the variation in Maximum support Reaction in 40 m & 70 m span model is 51% . so we can suggested that 40 m span is suitable for design and construction as well traffic planning also the 40 m span model is economical as compare to 70 m span model.

- **BEAM MAXIMUM STRESS COMPARE BETWEEN 40 M & 70 M SPAN MODEL**

SPAN	Fx(kN)	Fy(kN)	Fz(kN)	Mx(kNm)	My(kNm)	Mz(kNm)	RATIO
40M	34172	2475	2205	1961	12271	22888.09	**0.433**
70M	49368.23	12102.346	12798.54	3243.753	8137.466	89864.06	

Here it is observed that the variation in Axial force (Fx) in 40 m & 70 m span model is 69% . and Shear force (Fy) variation in 40 m & 70 m span model is 20%. And Maximum Bending moment (Mz) variation in 40 m & 70 m span model is 25%. so on the bases of above all variation we can suggested that 40 m span is suitable for design and construction as well traffic planning also the 40 m span model is economical as compare to 70 m span model.

- **NODES MAXIMUM DISPLACEMENT COMPARE BETWEEN 40 M & 70 M SPAN MODEL**

SPAN	X mm	Y mm	Z mm	Resultant	RATIO
40M	9.279	-205.391	-2.955	205.583	**0.254**
70M	17.599	-822.939	6.174	823.147	

- On the basis of all comparision and Rcc Design Result for all piers & girders in model with mid span of 40 m are similar that will make construction easier.
- On the basis of all comparision and Rcc design Result for all piers & girders in model with mid span of 70 m are different that will make construction difficult.
- Overall variation of Support Reactions for different load cases for model with span 40m is lower than model with span 70m.
- Overall variation of beam forces for different load cases for model with span 40m is lower than model with span 70m.
- Overall variation of beam stresses (compressive/tensile) for different load cases for model with span 40m is lower than model with span 70m.
- On the basis of all compression we suggested that 40m span is suitable for that location because the variation of all comparative results of 40m span model is very low as compare to 70 m span.

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