PARAMETRIC STUDY OF CURVED SPAN PSC BOX GIRDER BRIDGES AS PER IRC: 112: 2011

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ABSTRACT: Bridge is life line of road network, both in urban and rural areas. With rapid technology growth the conventional bridge has been replaced by innovative cost effective structural system. Box girders, have gained wide acceptance in freeway and bridge systems due to their structural efficiency, better stability, serviceability, economy of construction and pleasing aesthetics. Box girder design is more complicated as structure is more complex. Bridge design is an important as well as complex approach of structural engineer. The construction of curved span girder bridges in interchanges of modern highway system has become increasingly popular for economic and aesthetic reasons in many countries over the world. Particularly in India especially in growing cities such bridges of curved alignment have been used in the design of crowded urban areas where the multilevel interchanges must be built with inflexible geometric restrictions. Because of the addition of curvature, the design and the construction of curved box girder bridges is significantly more complicated than that of the straight bridges. With this aim the Parametric Study on Curved Span Box Girder Bridges considering the curved geometry for analysis and IRC: 112 CODE OF PRACTICE FOR CONCRETE ROAD BRIDGES for the design is performed. Span of Curved Bridge is 35 m consider. Carriage way width is 7.5 m having two lanes for that Single cell Box girder section & Carriage way width is 11.25 m having three lanes for that Double cell Box girder section is considered. Analysis and Design for Eight complete models of 100 m Radius curvature, 75 m Radius curvature, 50 m Radius curvature & Straight Span are to be prepared keeping the same depth 2.4 m of box girder cross section. The grade of concrete is 50 N/mm2 and grade of steel is 500 N/mm2. Analysis & Design is carried out using CSI Bridge 2015. On the completion of Analysis and Design; graphical relation between various parameters is prepared which in turn which will be useful to the structural designers for understanding of structural and economical aspects of curved box girder bridges. The graphical presentation of results includes comparison of shear force, bending moment, twisting moment, Prestressing Steel quantity, and Cost of Steel & Concrete.

Key Words: Curved Box Girder Bridges, PSC BOX Girders, IRC: 112

1.1 INTRODUCTION

Bridge is life line of road network in urban and rural areas. With speedy technology growth the conventional bridge has been replaced by innovative cost effective structural system. Box girders, have gained wide acceptance in freeway and bridge systems due to their structural efficiency, better stability, serviceability, economy of construction and pleasing aesthetics. Box girder design is more complicated as compare to the any other type of structure like PSC I girder or PSC Solid slab.

Bridge design is an important as well as complex approach of structural engineer. The construction of curved span girder bridges in interchanges of modern highway system has become more and more popular for economic and aesthetic reasons in many countries over the world. Particularly in India especially in growing cities such bridges of curved alignment have been used in the design of crowded urban areas where the multilevel interchanges must be built with inflexible geometric restrictions.

The span of curved bridges is more or nearly around 35 m in general to allow the smooth flow of traffic at interchanges. The cross-section used for such span is box girder and is usually prestressed. However, because of the addition of curvature, the design and the construction of curve box girder bridges is significantly more complicated than that of the straight bridges. The choice of economical and constructible structural system is depending on the result.

One example of such curve bridge is shown in figure 1.1 which is situated near Town Hall, on Ashram Road consist of box girder section and span of 35 m.

In India curved span girder bridges or even straight span bridges are generally designed based working stress design philosophy pioneered by the German professor Morsch. Indian Road Congress published IRC: 18 DESIGN CRITERIA FOR PRESTRESS CONCRETE ROAD BRIDGED (POST TENSIONED CONCRETE) in 2000 which is based on the working stress design philosophy. After that the IRC published IRC: 112 CODEOF PRACTICE FOR CONCRETE ROAD BRIDGES in November 2011 which is based on the limit state design philosophy.

1.2 OBJECTIVES

1. Objective of the dissertation is to perform the Parametric Study on Curved Span Box Girder Bridge considering the curved geometry for analysis and IRC: 112 Code (practice for concrete road bridge) for the design by the using of Software CSI Bridge 2015.
2. To prepare relation among various parameters and to prepare their charts which are directly useful for proper understanding of structural and economic aspects of curve span box girder bridges.

1.3 SCOPE OF WORK

1 Analysis and Design of curve span box girder bridges as per IRC: 112.
2 Span considered is 35m for the analysis and design considering the two lanes. Carriage way width is 7.5 m and over all Width of the PSC Box is 8.4 m
3 Span considered is 35m for the analysis and design considering the three lanes. Carriage way width is 11.25m. and over all Width of the PSC Box is 12.15 m

4 Single cell Box girder section having Crash-barrier on the deck slab is considered for Two lane (7.5 m) & Two cell Box Girder section having Crash-barrier on the deck slab is considered for Three Lane (11.25 m).
5 Eight complete models of 50 m Radius curvature , 75 m Radius curvature , 100 m Radius curvature & Straight Span are to be prepared for two lane Curved PSC Box Girder & Three Lane Curved PSC Box Girder with two different support conditions.
6 Depth of Curved PSC box Girder is considered 2.4 m & its constant.
7 Grade of concrete is 50 N/mm2 and grade of steel is 500 N/mm2 for all the above curvatures for the same span.
8 Charts for below parameters as per analysis point of view are prepared for 2 lane & 3 lane Curved PSC Box Girder Bridge
- Shear force Vs. Span section for each curvature
- Bending Moment Vs. Span section for each curvature
- Torsion Vs. Span section for each curvature

9 Charts for below parameters as per Design & Optimization point of view are prepared for 2 lane & 3 lane Curved PSC Box Girder Bridge
- Prestress Steel quantity Vs. Curvature of bridge
- Cost (Prestress Steel & Concrete) Vs. Curvature of bridge

1.4 DESIGN DATA

POST TENSIONED PSC CURVED BOX GIRDER BRIDGE – 35 MT (FOR 2 LANE)

1. Effective Span = 35 m
2. Width of Road = 8.4 m
3. Crash Barrier = 450 mm each side
4. Wearing Coat Thickness = 75 mm
5. Live load = IRC Class 70R or IRC Class A for 2 lane
6. PSC Box Girder Concrete Grade = M50
7. Loss Ratio = 0.85
8. C/C of Bearing = 5 m
9. Adopt Fe-500 grade HYSD bars.
10. 27K – 15 Freyssinet anchorages (27 stands of 15.2 mm diameter in 110 mm diameter cables conforming to IRC : 6006-2000)

POST TENSIONED PSC CURVED BOX GIRDER BRIDGE – 35 MT (FOR 3 LANE)

1. Effective Span = 35 m
2. Width of Road = 12.15 m
3. Crash Barrier = 450 mm each side
4. Wearing Coat Thickness = 75 mm
5. Live load = IRC Class 70R + class A or IRC Class A for 3 lane
6. PSC Box Girder Concrete Grade = M50
7. Loss Ratio = 0.85
8. C/C of Bearing = 5 m
9. Adopt Fe-500 grade HYSD bars.
10. 27K – 15 Freyssinet anchorages (27 stands of 15.2 mm diameter in 110 mm diameter cables conforming to IRC : 6006-2000)

1.5 ANALYSIS RESULT OF PSC CURVED BOX GIRDER BRIDGE OF 35 MT (FOR 2 LANE)

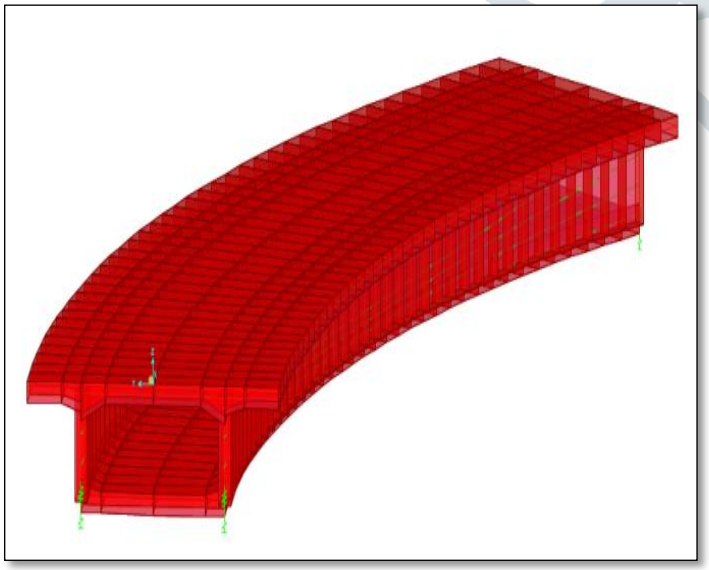


Fig : 3D View of Curved PSC Box

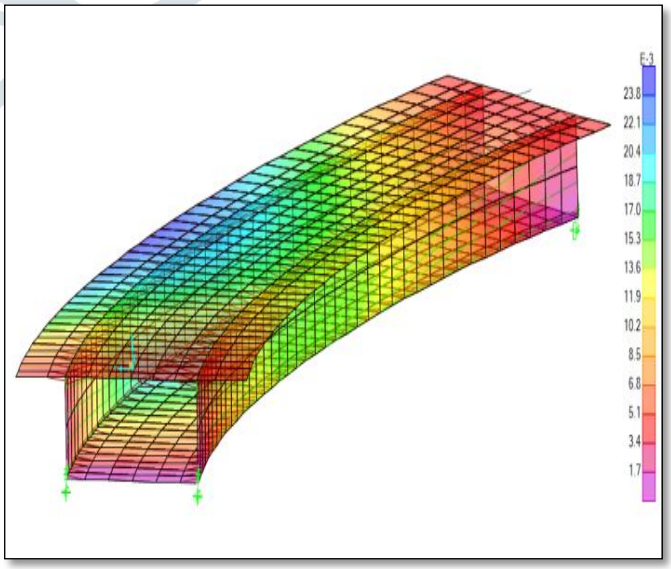


Fig : Contour shedding of Deformation shape

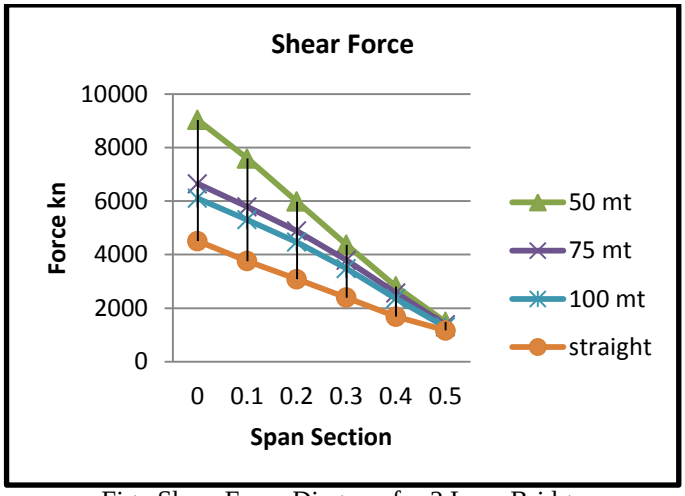


Fig : Shear Force Diagram for 2 Lane Bridge

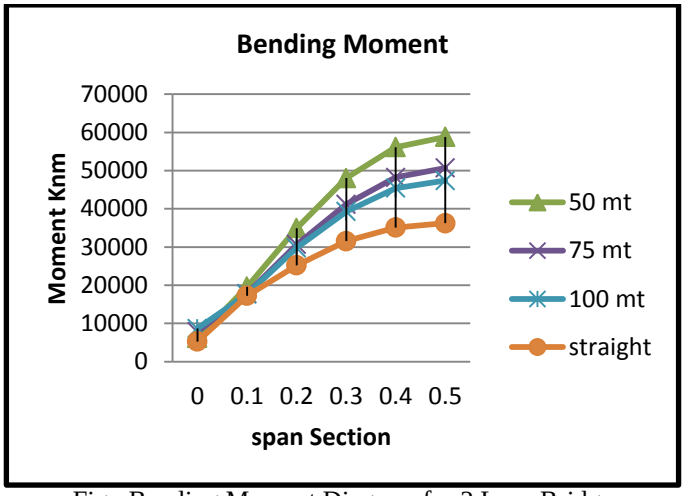


Fig : Bending Moment Diagram for 2 Lane Bridge

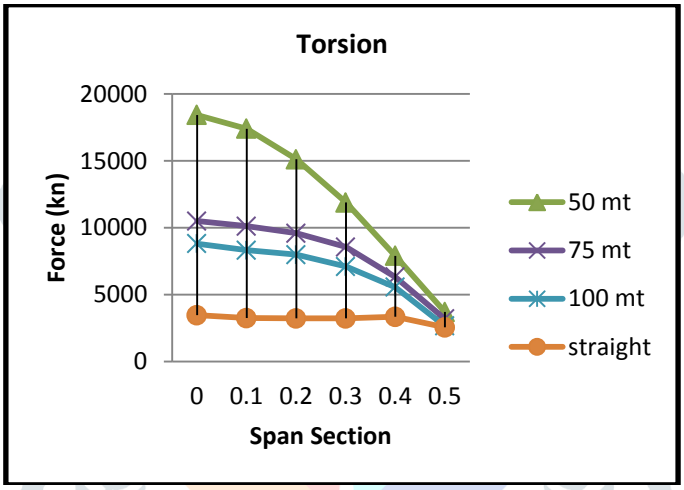


Fig: Torsion Diagram for 2 Lane Bridge

1.6 ANALYSIS RESULT OF PSC CURVED BOX GIRDER BRIDGE OF 35 MT (FOR 3 LANE)

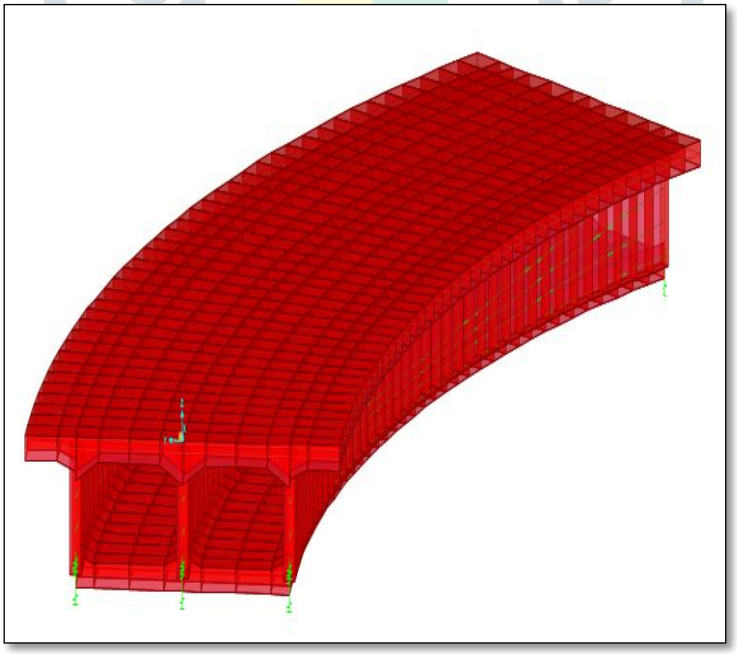


Fig: 3D View of Curved PSC Box

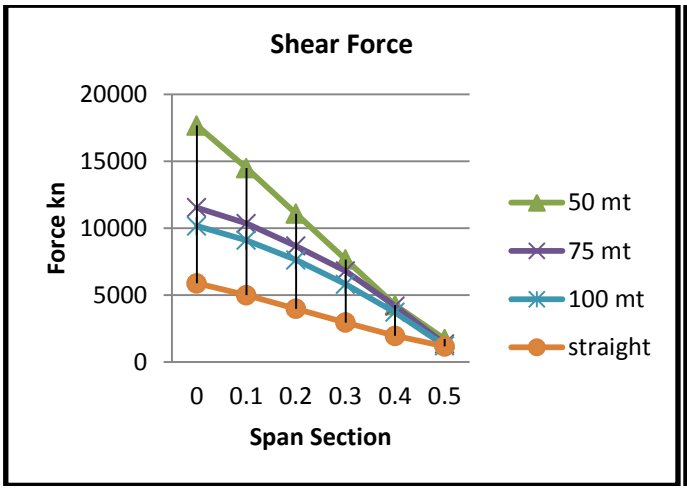


Fig: Shear Force Diagram for 3 Lane Bridge

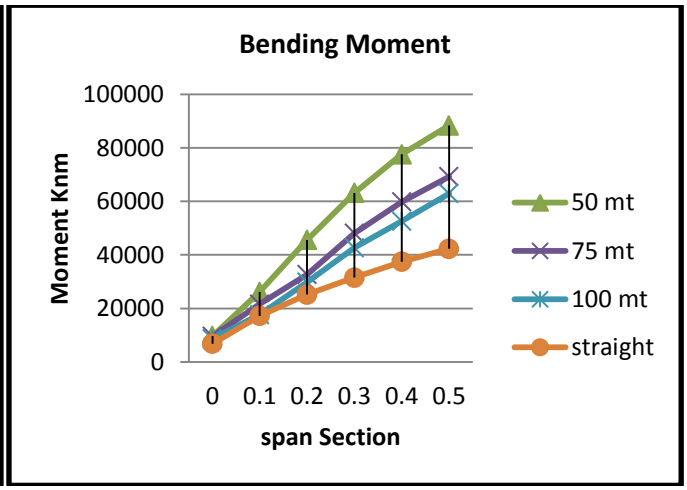


Fig: Bending Moment Diagram for 3 Lane Bridge

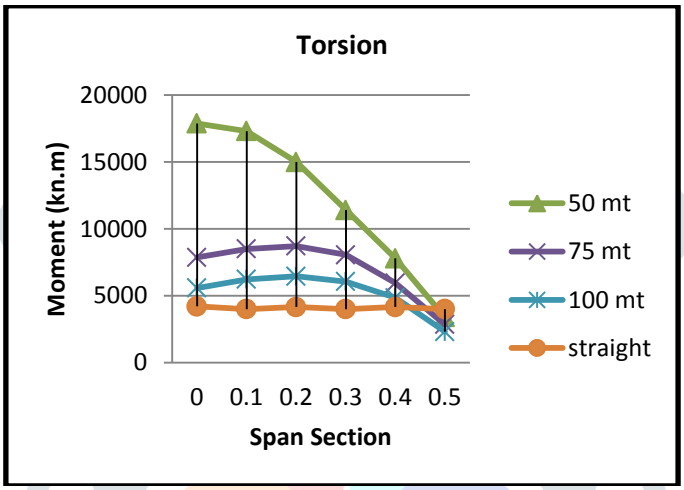
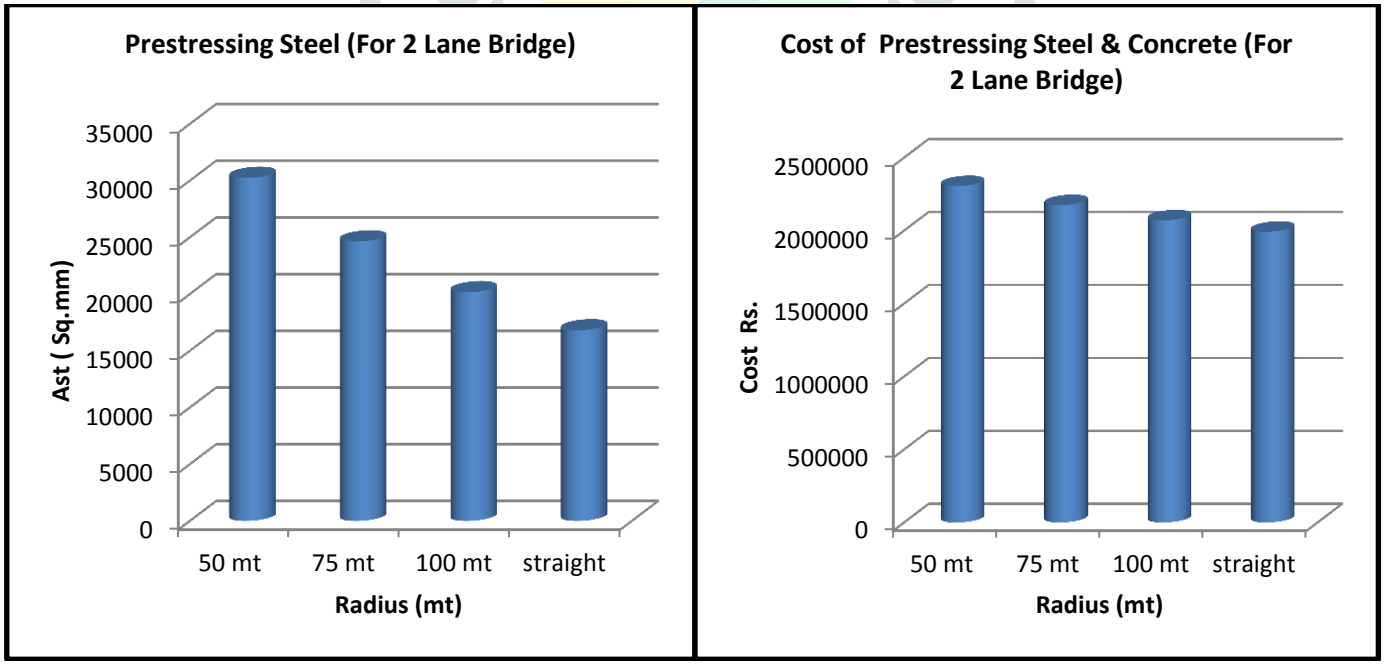


Fig: Torsion Diagram for 3 Lane Bridge

1.7 DESIGN RESULT OF PSC CURVED BOX GIRDER BRIDGE OF 35 MT (FOR 2 LANE)



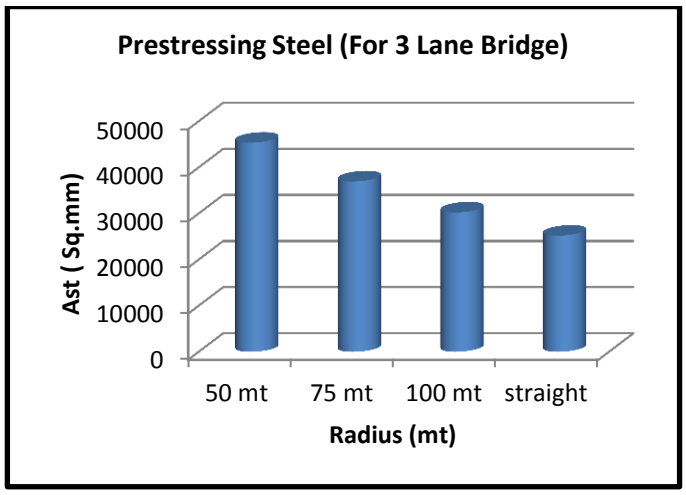
For Cost of Prestressing steel and concrete the standard rate taken from SOR (2015-2016) of Ahmedabad Municipal Corporation.

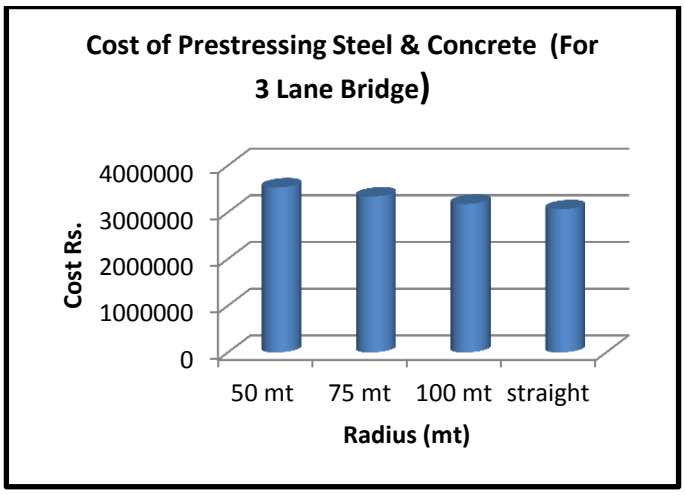
Rate of Item

Prestressing Steel :- 84,613 per Tonne

Concrete (M50) :- 6,604 per Cmt

1.8 DESIGN RESULT OF PSC CURVED BOX GIRDER BRIDGE OF 35 MT (FOR 2 LANE)





1.9 CONCUSION

The conclusions are drawn from the results obtained at the end of analysis and design for 100 mt radius, 75 mt radius, 50 mt radius degree of curvature & straight span for the 35 m span with 2 Lane & 3 Lane width.

1. With decrease of curve for the 35 m span, it's observed that there is speedy decrease in Shear Force as proceed from end section to mid section.
2. With increase of curve for the 35 m span, it's observed that there is speedy increase in bending moment as proceed from end section to mid section..
3. With decrease of curve for the 35 m span, it's observed that there is speedy decrease in Torsion as proceed from end section to mid section.
4. With increasing of curve for the 35 m span, it's observed that there is increase in required quantity of prestressing steel.
5. With increasing of curve for the 35 m span, it's observed that there is increase in the total cost of Prestrssing Steel and Concrete.

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