The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 3142 - 3152

Design Optimization of Bay Spacing of Steel Foot Over Bridge

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Abstract— Bridge is a structure that offers passage over limitations/obstacles which includes valleys, tough terrain or river or bodies of water via spanning such obstacles with herbal or manmade substances/material. The smooth kind of a bridge is steppingstones, so this may were one of the premature sorts of a foot bridge. Neolithic people also construct a shape of a boardwalk to the other facet of swamp, of which the sweet track, and the post track are examples from England, which are about 6000 years antique. Doubtless past peoples might also have used Timber Bridge that drop naturally. Different kinds of design foot over bridges consist of timber foot over bridges, steel foot over bridges and concrete foot over bridges. Steel truss is normally used round the world for the development of foot over bridges of different length. steel is a useful material that provides provable solution. Steel has long been diagnosed as the financial/economical option for a number of foot over bridges.

In the present study, design of economical section using different bay spacing is studied. For this purpose, analysis of foot over bridge has been carried out by using staad-pro software. The comparison is made based on weight of structure, utility ratio, Deflection. It is found about 50% weight of the structure is reduced after optimization.

Index Terms – Foot Over Bridge, Utility Ratio, Deflection.

Introduction

A foot over bridge is a bridge designed only for pedestrian. While the principle which means for a bridge is a structure which links “two distinct points at a peak above the earth”. The smooth kind of a bridge is steppingstones, so this may were one of the premature sorts of a foot bridge. Neolithic people also construct a shape of a boardwalk to the other facet of swamp, of which the sweet track, and the post track are examples from England, which are about 6000 years antique Doubtless past peoples might also have used Timber Bridge that drop naturally. Different kinds of design foot over bridges consist of timber foot over bridges, steel foot over bridges and concrete foot over bridges. Steel truss is normally used round the world for the development of foot over bridges of different length. steel is a useful material that provides provable solution. Steel has long been diagnosed as the financial/economical option for a number of foot over bridges.

After literature survey it is observed that, includes design and analysis of Foot over Bridge Using STAAD-PRO software, study mainly includes static and dynamic seismic analysis, specifically seismic coefficient method and response spectrum method is used But, yet bay spacing for economical design of steel foot over bridge has not been studied. So, in the present dissertation work, it is proposed to carry out bay spacing for the optimize/economical design of steel foot over bridge.

Literature Review

A bridge is a structure built for carrying the road/railway traffic or other moving loads over a depression or gap or obstacle such as river, channel, canyon, valley, road or railway. Depending on the purpose and the obstacle the type of bridge is selected to meet the requirement if a bridge is constructed to carry a highway traffic it is called highway bridge if it used to carry a railway traffic it is called as railway bridge the bridges that are constructed exclusively to carry pedestrians, cycle and animals are known as foot bridges and bridges used to carry canals and pipe lines are known as aqueduct bridge

Necessity of Foot Over Bridge

In recent trends there are various upcoming projects of foot over bridge in various sectors such as industrial or infrastructure. So, we have to design a economical section using bay spacing and how to change utility ratio with span increases and bay spacing changes. We have to see the changes in utility ratio with built-up sections for different span variations of bay spacing and adopt economical section. Therefore, in the present dissertation work, it is proposed to carry out bay spacing for economical/optimize design of steel foot over bridge.

Modelling and analysis

To obtain and compare the results for different bay spacing different types of model designed and analysis ids carried out by using staad-pro software.

A. Problem Data For design Of Foot Over Bridge

Type of Structure:	Steel
Seismic zone:	III
Resonance Reduction Factor:	3
Size of span & bay spacing:	10m Span & 2m bay spacing 10m Span & 3m bay spacing 10m Span & 4m bay spacing 10m Span & 5m bay spacing 15m Span & 2m bay spacing 15m Span & 3m bay spacing 15m Span & 4m bay spacing 15m Span & 5m bay spacing
Importance Factor:	1.5
Soil Type:	Hard
Damping Ratio:	0.02

The Ciência & Engenharia - Science & Engineering Journal
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Volume 11 Issue 1, 2023
pp: 3142 - 3152

Self-weight floor load:	-2KN/m^2
Pressure on floor:	-5KN/m^2
Wind Load Intensity:	0.18kN/m^2
Height:	4 m

B. Step By Step Procedure of Analysis In STAAD-PRO V8i.

Define Material Properties:

The material properties of concrete and steel are given. for concrete properties like weight perunit volume, modulus of elasticity, poisons ratio must be given. For steel minimum yield strength is required and for Fe415, it is 415000kN/m^2

Define Section Properties

The frames section properties of all truss member size, thickness size is given. Bay spacing for different span arrangements are given.

Develop The Model And Assign The Joint Restraints:

In this step, preparing model by adding frame objects with the associated properties. Once the model is prepared next step is assigning joint restraints. For building frame, the joint restraints one end is fixed and another end is fixed but.

Develop Load Pattern And Assign To Frame:

In this step, the load patterns like dead load, dead wall, floor finish, live load are defined. Theloading is given to the frame. The mass source is defined the all dead load are considered 100%. Then all joints are making rigid by joint constraints. The loading combinations are given.

Run The Analysis :

The value for utility ratio, weight of structure and deflection for different bay spacing must be check.

Verify All Members Are Passed:

Verify every element of structure is passed through check.

Design the section for optimum design:

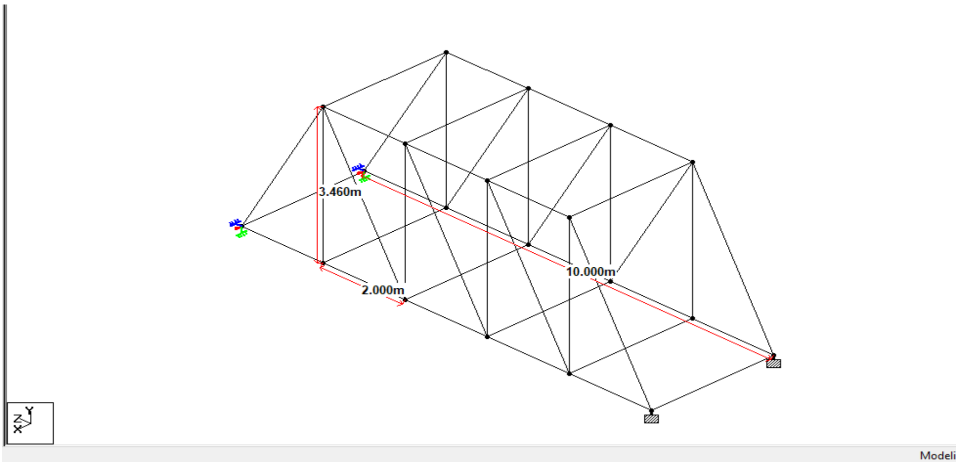

Fig 1. Geometry of structure

The Ciência & Engenharia - Science & Engineering Journal
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Volume 11 Issue 1, 2023
pp: 3142 - 3152

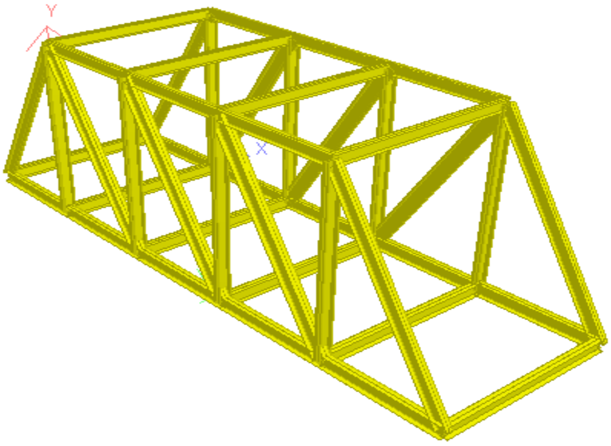

Fig.2. 3D Rendered View of Structure

Results and Discussion

This chapter generally represents the results of analysis of foot over bridge for different bay spacings. Analysis has been done by using Staad Pro V8i software.

a. Utility Ratio:

Utilization ratio for all the members is less than 1 for foot over bridge of 6m span and 2m bay spacing.

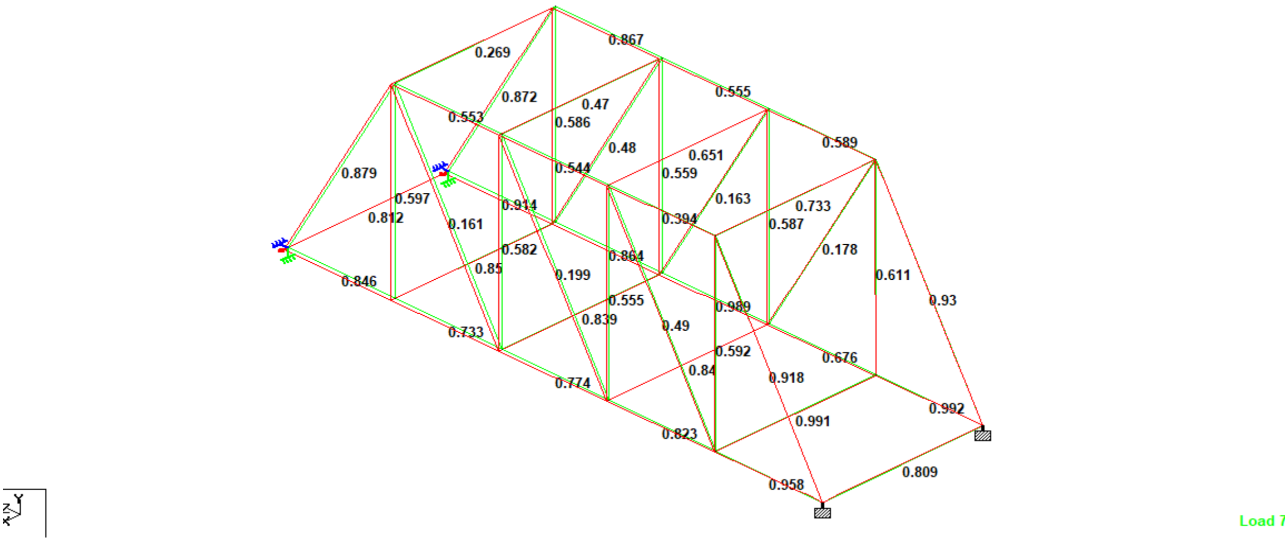

Fig. 3 Utility Ratio for 10m span and 2m bay spacing

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 3142 - 3152

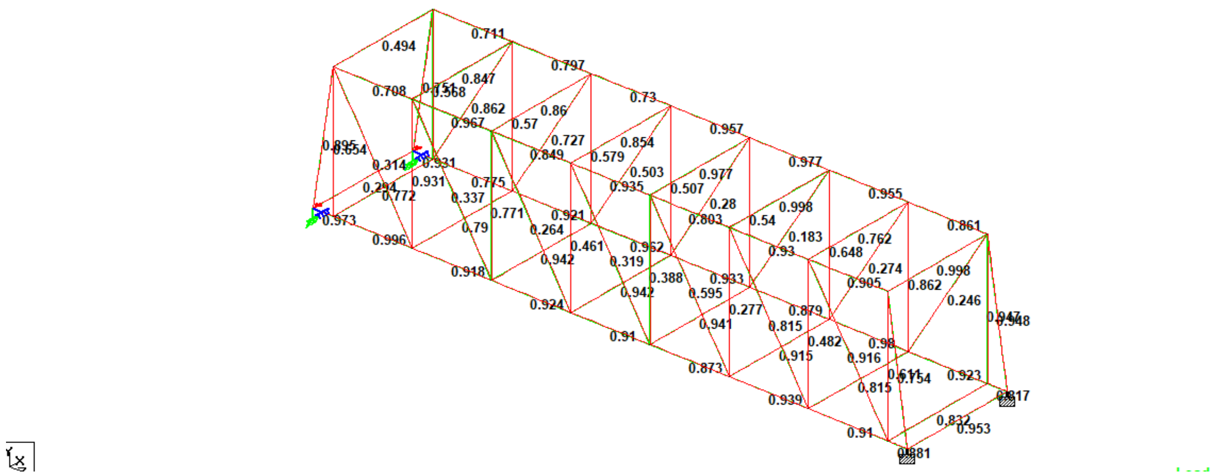

Fig. 4 Utility Ratio for 15m span and 2m bay spacing

b. Deflection :-

Maximum Deflection for Different Span and Bay Spacing Arrangement is shown in table below –

Sr. No.	Span Arrangement	Maximum Deflection (mm)
1	2m Bay Spacing 10m Span	2.6252
2	3m Bay Spacing 10m Span	2.557
3	4m Bay Spacing 10m Span	3.733
4	5m Bay Spacing 10m Span	2.525
5	2m Bay Spacing 15m Span	5.272
6	3m Bay Spacing 15m Span	4.556
7	4m Bay Spacing 15m Span	5.393
8	5m Bay Spacing 15m Span	48.672

c. Weight of the structure :-

i. for 10m span and 2m bay spacing

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STEEL TAKE-OFF
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   PROFILE                    LENGTH(METE)        WEIGHT(KN   )

ST   ISLB175                      36.68               6.002
ST   ISLB75                        4.00               0.237
ST   ISLB100                      10.00               0.784
ST   ISLB125                      30.00               3.480
ST   ISWB150                       3.00               0.500
ST   ISSC100                      39.96               7.829
ST   ISLB150                       2.00               0.278
ST   ISLBP175                      2.00               0.326
ST   ISJB200                       2.00               0.194
                                               ----------------
                               TOTAL =               19.628
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Fig. No. 5 Steel Take-off

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 3142 - 3152

ii. for 15m span and 2m bay spacing

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STEEL TAKE-OFF
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   PROFILE                    LENGTH(METE)      WEIGHT(KN   )

ST   ISHB250                        3.50              1.748
ST   ISHB200                        7.00              2.554
ST   ISSC140                        4.00              1.303
ST   ISHB150                       10.00              2.650
ST   ISSC120                       17.99              4.617
ST   ISWB175                       11.99              2.589
ST   ISLB200                       14.42              2.803
ST   ISLBP175                       2.00              0.326
ST   ISJB225                        0.50              0.063
ST   ISJB150                        3.00              0.208
ST   ISHB225                        3.50              1.476
ST   ISSC150H                       3.00              1.085
ST   ISLB150                        7.00              0.973
ST   ISLB125                       17.00              1.972
ST   ISLB175                       67.44             11.035
ST   ISMB175                        3.00              0.574
ST   ISSC100                       52.96             10.374
ST   ISLB75                         2.00              0.118
ST   ISWB150                        6.99              1.166
                                          ---------------
                                    TOTAL =          47.632


************ END OF DATA FROM INTERNAL STORAGE ************
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Fig. No. 5 Steel Take-off

Sr. No.	Span Arrangement	Weight of structure (M.T.)		Steel structure price per M. T.		% Cost saving
		Before Optimization	After Optimization	Before Optimization	After Optimization	
1	2m Bay Spacing 10m Span	3.86	1.96	231600	117600	49.22
2	3m Bay Spacing 10m Span	4.27	2.77	256200	166200	35.13
3	4m Bay Spacing 10m Span	3.65	2.54	219000	152400	30.41
4	5m Bay Spacing 10m Span	3.08	2.73	184800	163800	11.36
5	2m Bay Spacing 15m Span	7.28	4.76	436800	285600	34.62
6	3m Bay Spacing 15m Span	5.49	4.09	329400	245400	25.50
7	4m Bay Spacing 15m Span	4.99	3.98	299400	238800	20.24
8	5m Bay Spacing 15m Span	6.15	3.27	369000	196200	46.83

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 3142 - 3152

d. Structure before optimization and after optimization: -

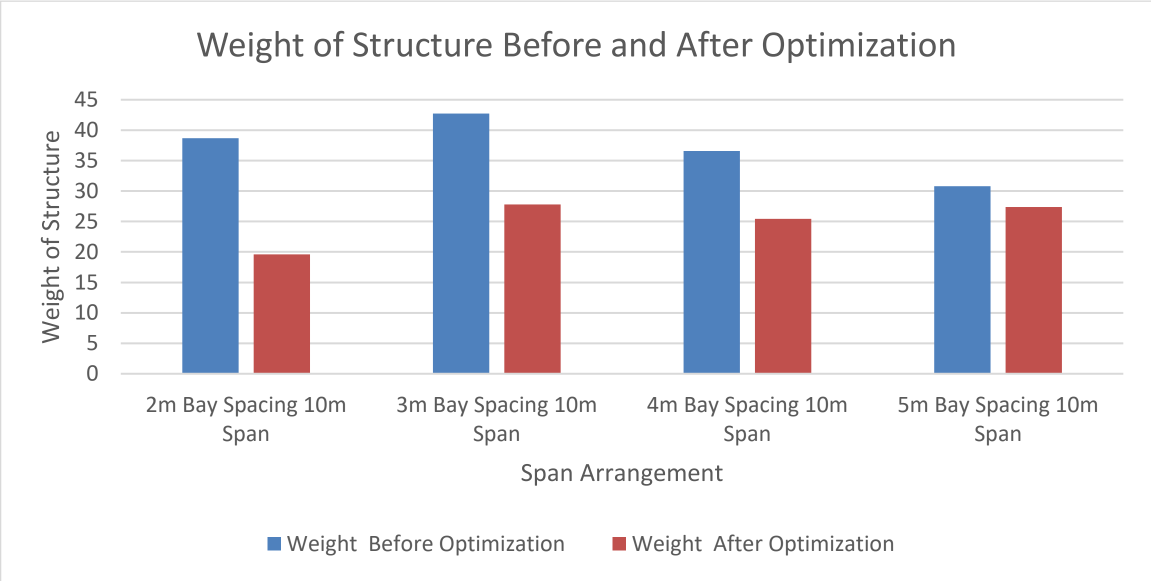

Fig. No. 8 Comparison Weight of Structure Before and After Optimization (10m Span)

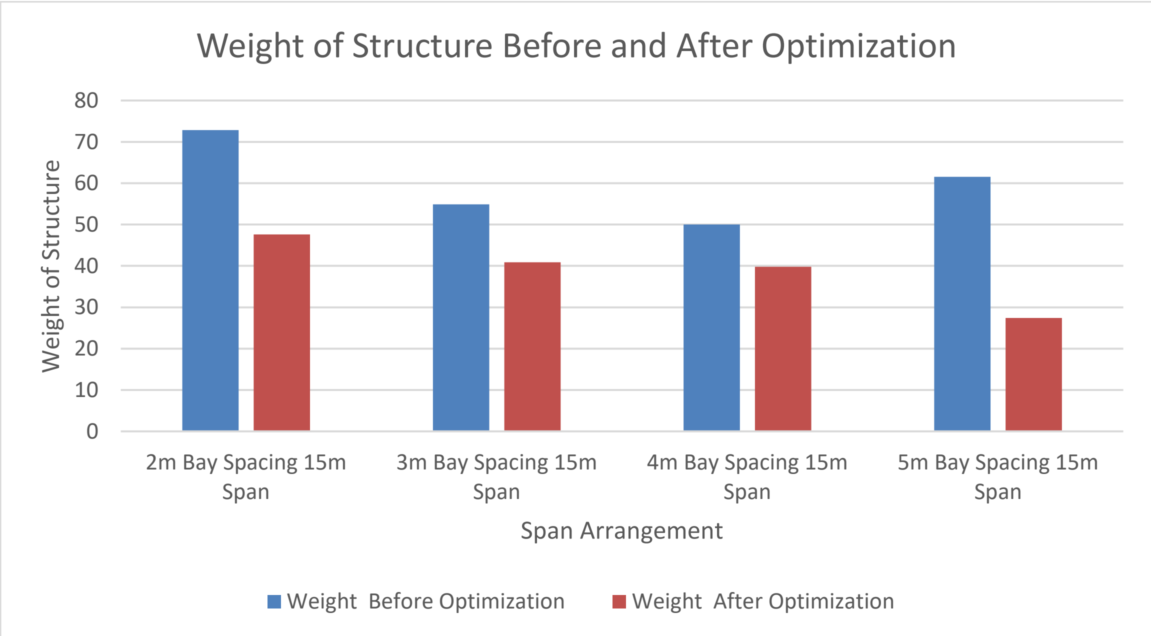

Fig. No. 8 Comparison Weight of Structure Before and After Optimization (15m Span)

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 3142 - 3152

e. Comparison of maximum utility ratio: -

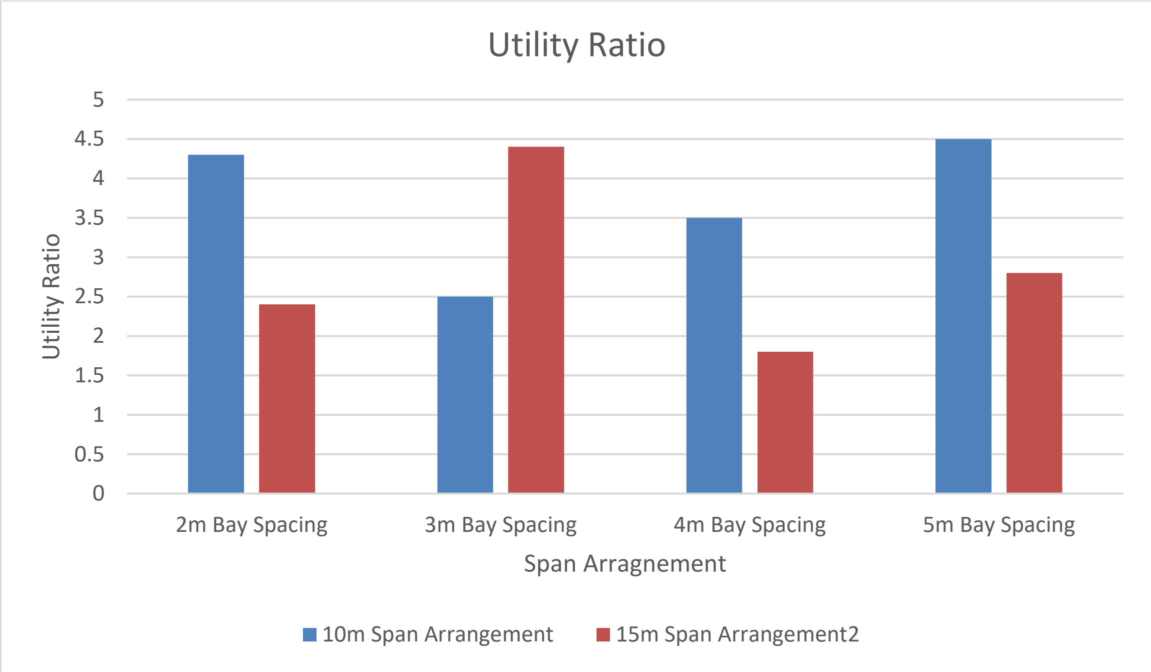

Fig. No. 9 Maximum utility ratio

f. Comparison of Deflection of Structure in mm: -

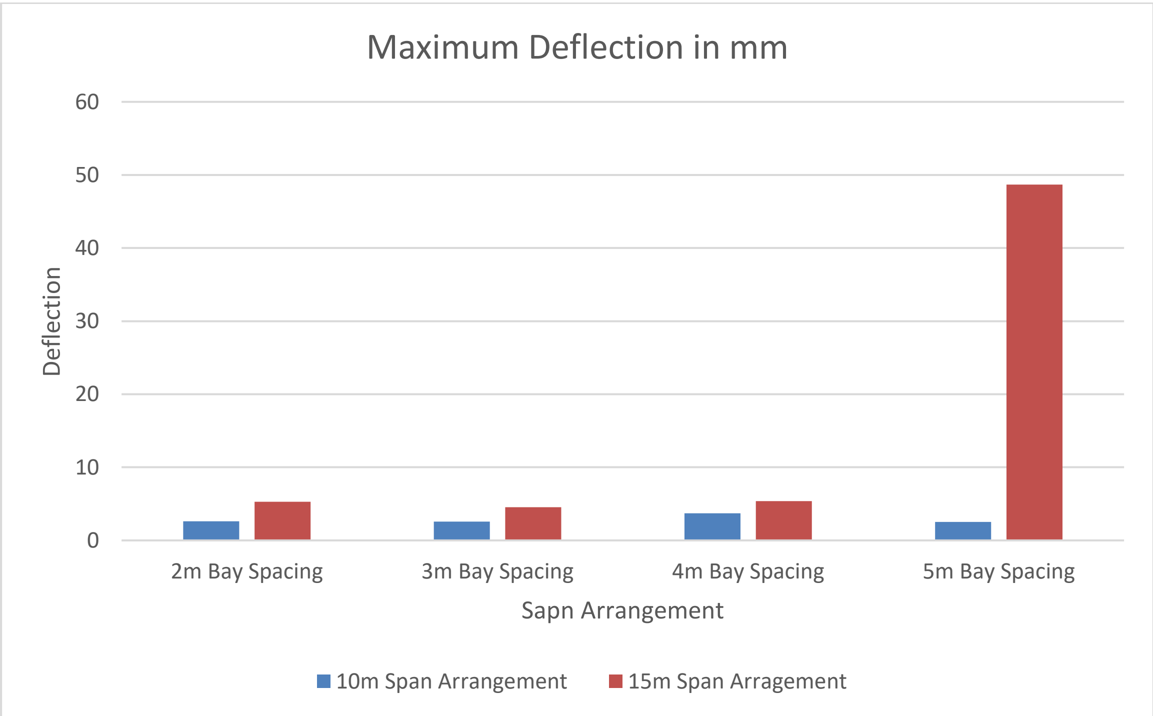

Fig. No.10 Comparison of Deflection of Structure in mm

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 3142 - 3152

Conclusion

After analysis and design of steel foot over bridge by using STAAD PRO for different bay spacing and different span, the following points are observed

From software analysis, weight of steel foot over bridge after optimization is reduced by about 49% & 34% for 2m bay spacing for 10m and 15m span respectively i.e., economical section is achieved.

2m, 3m & 4m bay spacing steel foot over bridge are safe as maximum utility ratio is under 1.

The utility ratio increases with the increase in bay spacing for span under consideration.

We can say that 2m, 3m & 4m bay spacing can be comfortable with different span length, as structure is safe for these bay spacings.

The 5m bay spacing steel foot over bridge is not preferable as maximum utility ratio is above 1.

The economical steel foot over bridge after the analysis and design in 2m bay spacing and 10m span.

As the span of steel foot over bridge increases the weight of the steel foot over bridge will also be increased keeping the bay spacing constant.

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