Parametric Study of Behaviour of Curved Concrete Box Girder Bridge under Different Shape

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Abstract

The present study focus on the behavior of curved box Girder Bridge with different shape and span length. The bridge is modelled and analyzed in CSI Bridge software. The cross section of superstructure of the box girder bridge is in form of a single cell. The curvature varies only in horizontal direction. All the models are subjected to dead load and super imposed dead load. From this study we conclude that clipped section is superior to circular, trapezoidal and rectangle section.

Keywords—Conceret box girder; different shape of girder; different of span length; CSI Bridge.

Introduction

A box girder bridge is a bridge in which the main beams comprise girders in the shape of a hollow box. The box girder normally comprises of either prestressed concrete, structural steel, or a composite of steel and reinforced concrete. Box girders can be constructed as single cell, double cell or multi-cell. It may be monolithically constructed with the deck, called closed box girder or the deck can be separately constructed afterwards called open box girder. Box girders may be rectangular, trapezoidal, clipped and circular. [1]

Analysis and design of box-girder bridges are very complex due to its three dimensional behaviors consisting of torsion, and bending in longitudinal and transverse directions. Analysis and design of the box girder can be divided into two parts i.e. longitudinal analysis and transverse analysis. In each analysis method, the three-dimensional bridge structure is modelled by means of assumptions in the geometry, materials and the relationship between its components. The accuracy of analysis depends on the assumptions taken for bridge structure. [2]

Problem Definition

In this study mainly four types of box girder used for analysis namely Trapezoidal, Rectangular, clipped and circular. The cross section are shown in Fig. 1,2,3,4 respectively.

The analysis of bridge is done for constant radius of curvature of 100m having all the four shapes with same cross sectional area. The depth is made constant. The only changing parameter is the span length of 30m, 50m and 70m.

In this analysis dead load and super imposed dead load are consider. Super imposed dead load is included with wearing surface (80 mm thick) and crash barrier load.

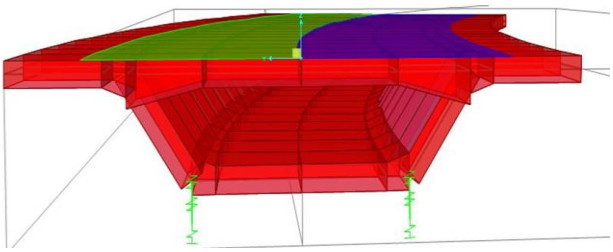


Fig.1.Trapezoidal box girder

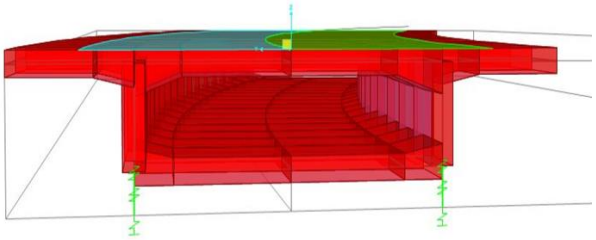


Fig.2.Rectangular box girder

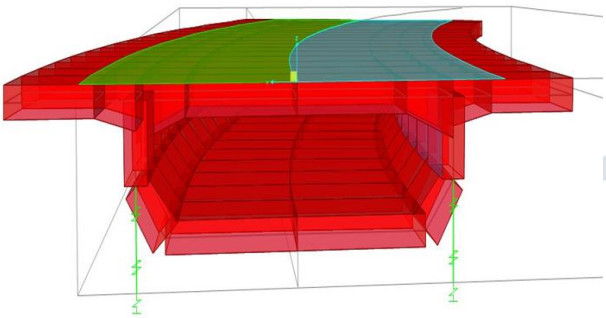


Fig.3. Clipped box girder

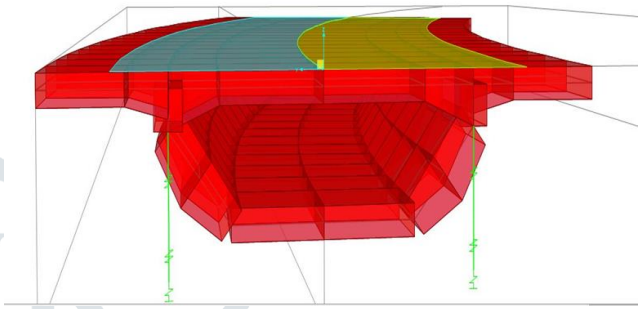


Fig.4.Circular box

Methodology

i. Twelve models (3 models of trapezoidal, 3 models of rectangular, 3 models of clipped and 3 models of circular box girder) with same cross section area and different span length are modelled in CSI Bridge software.

ii. All models are subjected to Dead load and super imposed dead load.

iii. Static analysis is done for dead load and super imposed dead load.

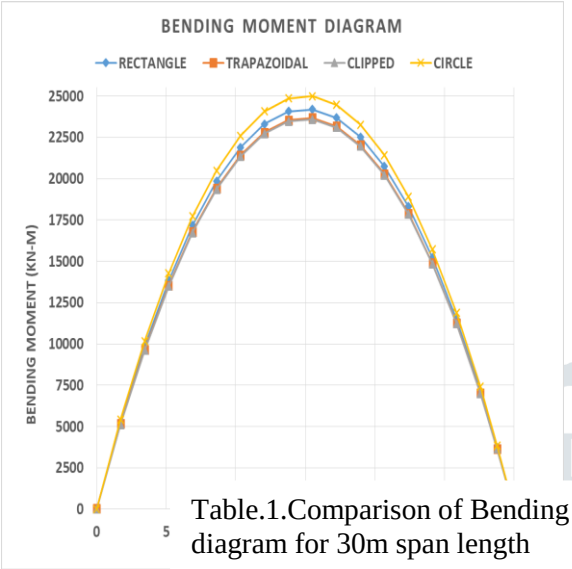
iv. The responses of all four box girders are compared.

Result and Discussion

All models are analyzed and comparison of bending moment, shear force, torsion and deflection are present graphically and in tabular form as below:

For 30 m span length

Bending Moment Diagram of 30m span length



SECTIONS	MAX. BENDING MOMENT (KN-M)	DIFFERENCE W.R.T. CLIPPED SECTION
CLIPPED	23592.58	-
RECTANGLE	24202.87	2.59 %
TRAPAZOIDAL	23677.85	3.20 %
CIRCULAR	24998.36	5.95 %

Table.1.Comparison of Bending moment diagram for 30m span length

ing moment diagram for 30m span length

From result, circular section has higher bending moment about 6% than clipped section.

Shear Force Diagram for 30m span length

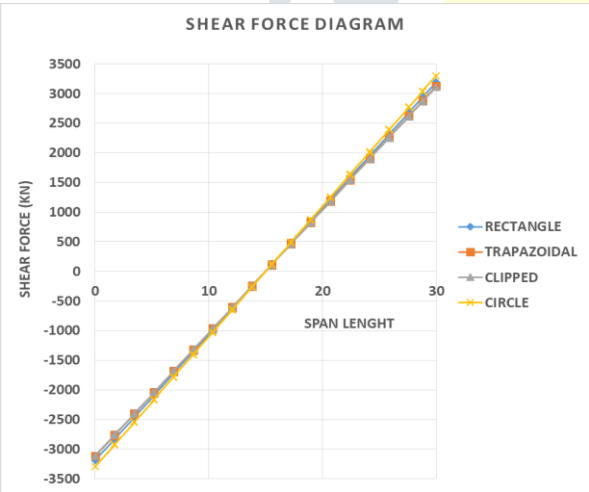


Fig.6. Shear Force diagram for 30m span length

SECTIONS	Max. Shear Force (KN)	DIFFERENCE W.R.T. Clipped Section
CLIPPED	3112.73	-
RECTANGLE	3193.33	2.61 %
TRAPEZOIDAL	3124.00	0.40 %
CIRCLE	3298.63	6.00 %

Table.2. Comparison of Shear Force diagram for 30m span length

From result, circular section has higher Shear force about 6% than clipped section.

Torsion Diagram for 30m span length

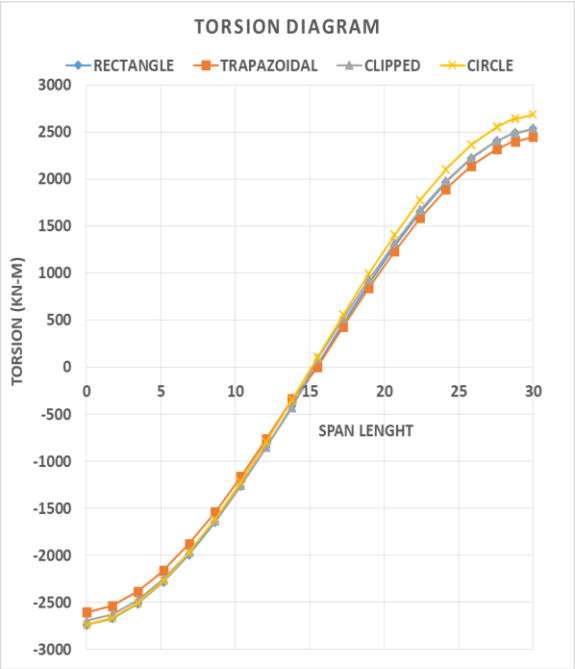


Fig.7. Torsion diagram for 30m span length

SECTIONS	Max. Torsion (KN-M)	DIFFERENCE W.R.T. Clipped Section
CLIPPED	2447.85	-
RECTANGLE	2537.50	3.66 %
TRAPEZOIDAL	2534.56	3.54 %
CIRCLE	2688.80	9.84 %

Table.3. Comparison of Torsion diagram for 30m span length

From result, circular section has higher torsion about 10% than clipped section.

Deflection Diagram for 30m span length

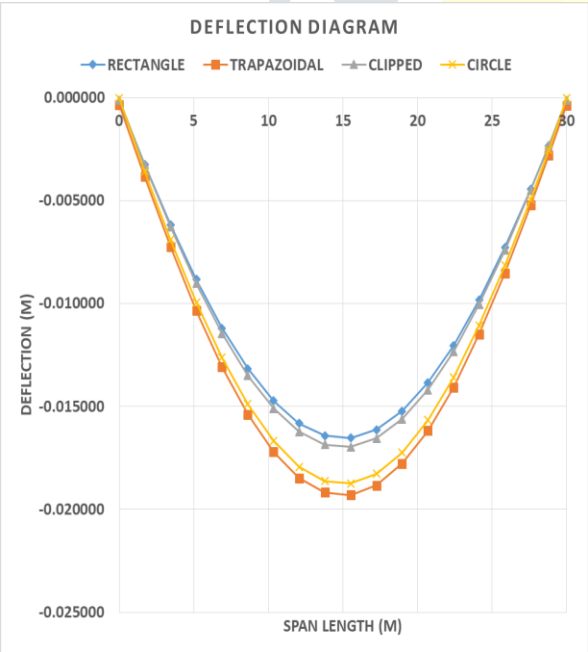


Fig.8. Deflection diagram for 30m span length

SECTIONS	DEFLECTION (mm)	DIFFERENCE W.R.T. Rectangle section
RECTANGLE	16.52	-
TRAPEZOIDAL	19.30	16.82 %
CLIPPED	16.96	2.66 %
CIRCLE	18.74	13.44 %

Table.4. Comparison of Deflection diagram for 30m span length

From result, trapezoidal section has higher deflection about 17% than clipped section.

For 50m span length

Bending Moment Diagram for 50m span length

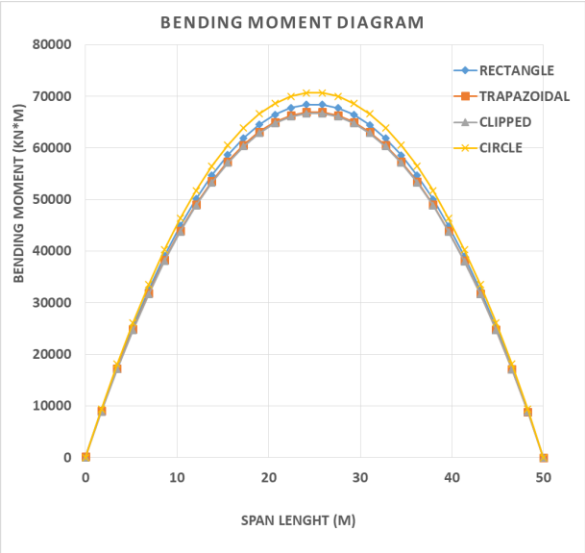


Fig.9. Bending moment diagram for 50m span length

SECTIONS	MAX. BENDING MOMENT (KN-M)	DIFFERENCE W.R.T. CLIPPED SECTION
CLIPPED	66659.83	-
RECTANGLE	68388.98	2.60 %
TRAPAZOIDAL	66915.91	3.86 %
CIRCULAR	70628.67	5.96 %

Table.5. Comparison of bending moment diagram for 50m span length

From result, circular section has higher bending moment about 6% than clipped section.

Shear Force Diagram for 50m span length

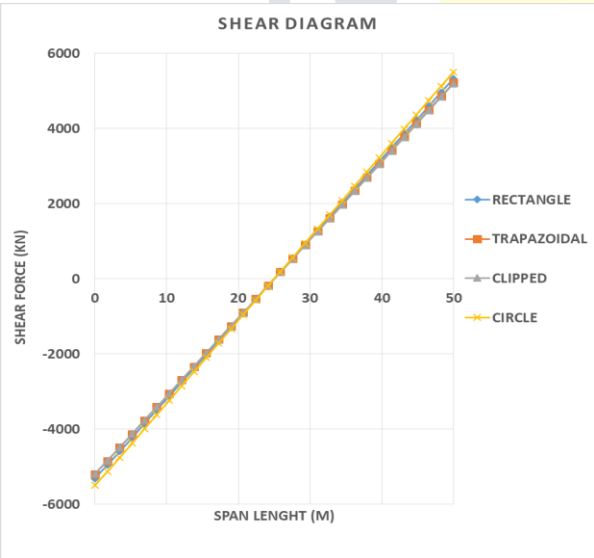


Fig.10. Shear force diagram for 50m span length

SECTIONS	Max. Shear Force (KN)	DIFFERENCE W.R.T. Clipped Section
CLIPPED	5191.66	-
RECTANGLE	5327.17	2.64 %
TRAPEZOIDAL	5213.56	4.35 %
CIRCLE	5500.92	5.97 %

Table.6. Comparison of shear force diagram for 50m span length

From result, circular section has higher shear force about 6% than clipped section.

Torsion Diagram for 50m span length

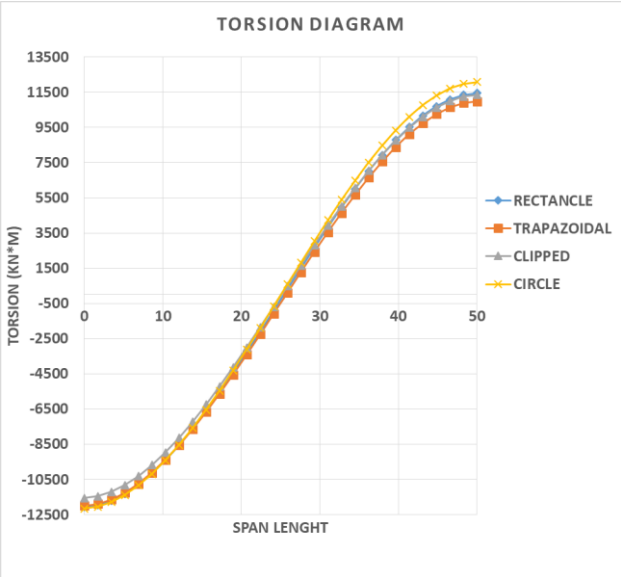


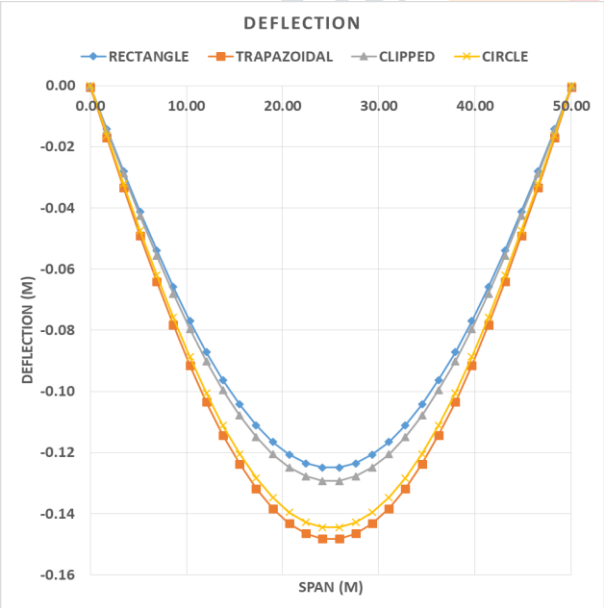
Fig.11. Torsion diagram for 50m span length

SECTIONS	Max. Torsion (KN-M)	IFFERENCE W.R.T. Trapezoidal Section
CLIPPED	10984.27	-
RECTANGLE	11446.33	4.21 %
TRAPEZOIDAL	11352.63	3.35 %
CIRCLE	12083.14	10.00 %

Table.7. Comparison of torsion diagram for 50m span length

From result, circular section has higher shear force about 10% than clipped section.

Deflection Diagram for 50m span length



SECTIONS	DEFLECTION (mm)	DIFFERENCE W.R.T. Rectangle section
RECTANGLE	124.89	-
TRAPEZOIDAL	148.16	19.48 %
CLIPPED	129.25	3.50 %
CIRCLE	144.43	15.65 %

Table.8. Comparison of deflection diagram for 50m span length

Fig.12. Deflection diagram for 50m span length

From result, trapezoidal section has higher deflection about 20% than clipped section.

For 70m span length

Bending Moment Diagram for 70m span length

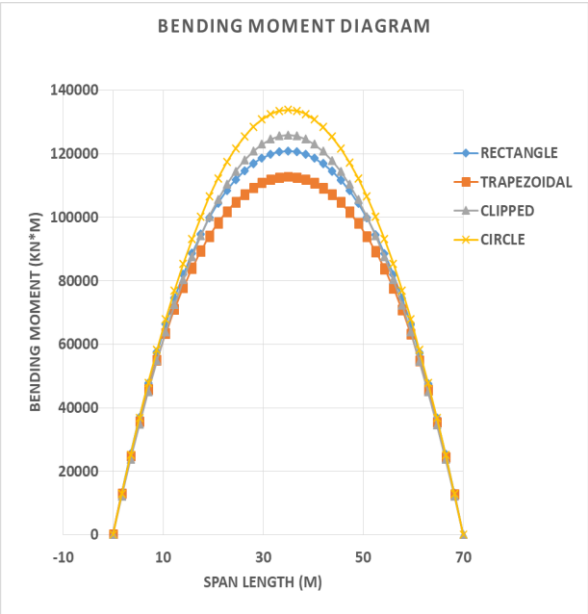


Fig.13. Bending moment diagram for 50m span length

SECTIONS	MAX. BENDING MOMENT (KN-M)	DIFFERENCE W.R.T. CLIPPED SECTION
CLIPPED	112723.09	-
RECTANGLE	120827.98	7.20 %
TRAPEZOIDAL	125857.00	11.65 %
CIRCULAR	133845.20	18.74 %

Table.9. Comparison of bending moment diagram for 50m span length

From result, circular section has higher bending moment about 19% than clipped section.

Shear Force Diagram for 70m span length

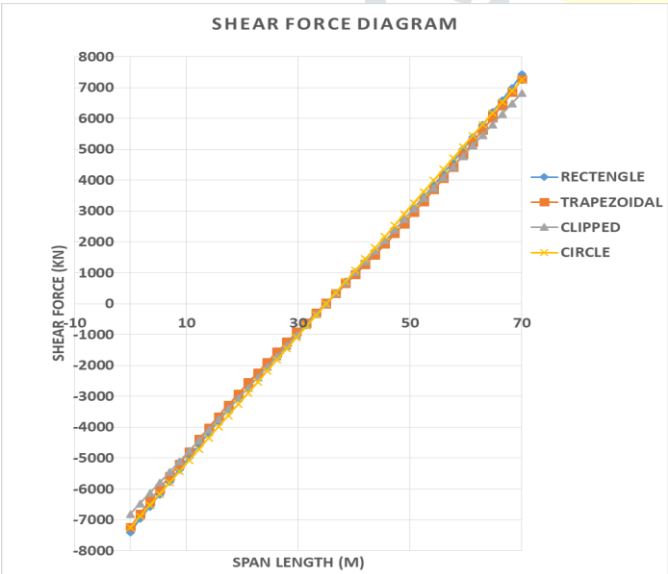


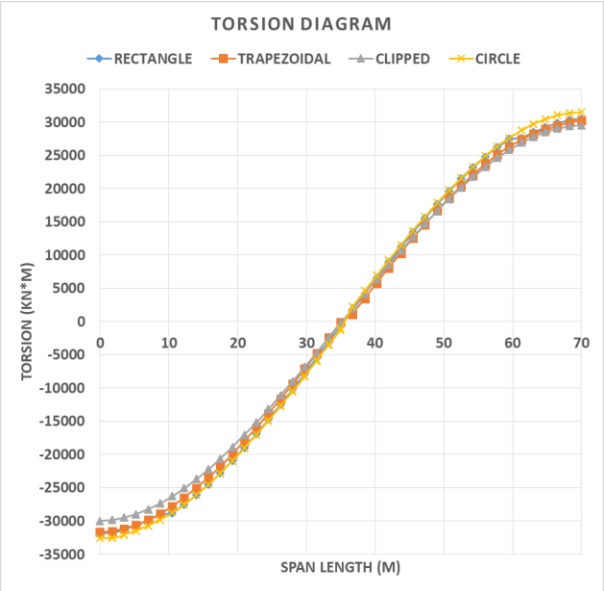
Fig.14. Shear force diagram for 50m span length

SECTIONS	Max. Shear Force (KN)	DIFFERENCE W.R.T. Clipped Section
CLIPPED	6822.15	-
RECTANGLE	7254.46	6.34%
TRAPEZOIDAL	7271.98	6.60 %
CIRCLE	7427.89	8.88 %

Table.10. Comparison of shear force diagram for 50m span length

From result, circular section has higher shear force about 9% than clipped section.

Torsion Diagram for 70m span length



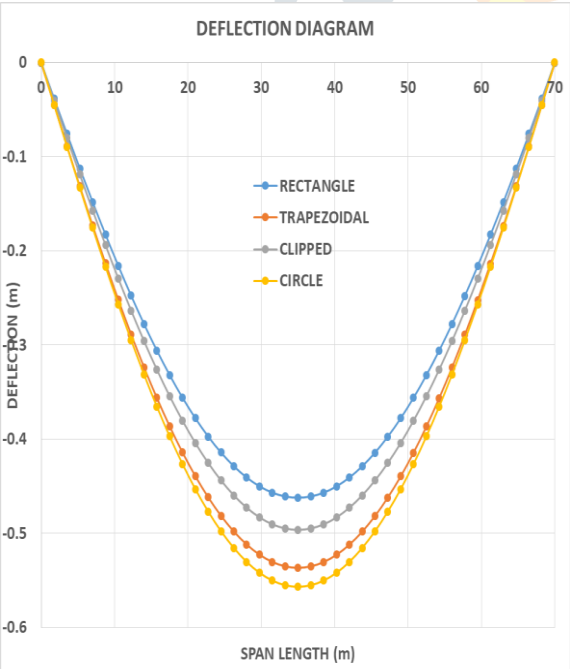
SECTIONS	Max. Torsion (KN-M)	DIFFERENCE W.R.T. Trapezoidal Section
CLIPPED	29510.60	-
RECTANGLE	31519.18	6.80 %
TRAPEZOIDAL	30225.57	2.42 %
CIRCLE	31521.50	6.82 %

Table.11. Comparison of torsion diagram for 50m span length

Fig.15. Torsion diagram for 50m span length

From result, circular section has higher torsion about 7% than clipped section.

Deflection Diagram for 70m span length



SECTIONS	DEFLECTION (mm)	DIFFERENCE W.R.T. Rectangle section
RECTANGLE	462.07	-
TRAPEZOIDAL	536.50	16.13 %
CLIPPED	496.21	7.40 %
CIRCLE	556.67	20.49 %

Table.11. Comparison of torsion diagram for 50m span length

Fig.16. Deflection diagram for 50m span length

From result, circular section has higher shear force about 21% than clipped section.

Conclusion

1) For all span, Circular box girder have higher Bending Moment, Shear Force and Torsion.
2) For all span, Trapezoidal box girder has higher Deflection.
3) For 30 m and 50 m span, Result variations are nearly same for particular box girder.
4) For 70 m span, Result variation are high compare to 30 m and 50m span

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