Parametric Study of Various Structural System for Lateral Load in Multi Storey Building

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***Abstract* - This article present parametric study of different structural system, like moment resistance frame, moment resistance frame with shear wall, moment resistance frame with bracing, frame tube with core, outrigger with belt truss. It is very important to ensure the adequate stiffness of structure against the lateral loading caused by wind and earthquake. In this study we have considered 10, 20, 30, 40 storey building for each system and compered to Base shear, Displacement, and Storey Drift. In this study analysis and design done by using IS 456, IS 1893-2002, IS 875 Part – 3.**

***IndexTerms* - Structural System, Structural Parameter, Static and Dynamic analysis, ETABS 2015**

1. INTRODUCTION

In tall structure construction, proper structural system used more important to lateral stability, against the earthquake and wind. Different lateral structural system are getting stability against the lateral forces in the tall structure. Behaviour of different structural systems is having different load transfer mechanism. Generally in case of high-rise structure, stiffness requirement in terms of inter storey drift and top storey displacements are important criteria to control.

1.1 Structural Systems

1.1.1 Moment Resistance system

Moment resisting frame is assembly of the columns and beams, joined by moment resisting frame connections. Building performance during the earthquake, criteria of building will depend on material, strength, and ductility of structure components and detailing of reinforcement. Moment resistance system are capable to resist to both type of load gravity load and lateral load safely. And also control to structure parameter like displacement, storey drift.

When the building are tall, beam and column size becomes heavy, and steel area required large so that limitation of moment resistance system to some height.

1.1.2 Moment Resistance System With Shear wall

Shear walls have very high in plan stiffness and strength, which can be used to simultaneously resistance large horizontal loads and support gravity load. Shear wall can be defined as structural vertical member that is able to resist combination of shear, moment, and axial load by the gravity and lateral load transfer to the wall from other structural member.

1.1.3 Moment Resistance System with Bracing

- **Type of bracing**
  (1) Concentrically braced frame
  (2) Eccentrically braced frame

(1) Concentrically braced frame

Concentrically braced frame consists of diagonal brace member pinned to beam column junction. The braced impart high elastic stiffness. Which are allowed designing the structure with small drift.

(2) Eccentrically braced frame

Eccentrically braced frame arranged that at least one of end of each brace is connected is to isolate a segment of beams called a link. By combination of frame and truss action, they resist lateral force and by flexural and shear yielding develop ductility in link.

1.1.4 Frame Tube with Core

Frame tube is simplest is the perimeter closed spaced column and connected by deep beams. The system has large open floor area with few interior columns design only for vertical load to carry, and total lateral load the exterior columns are designed.

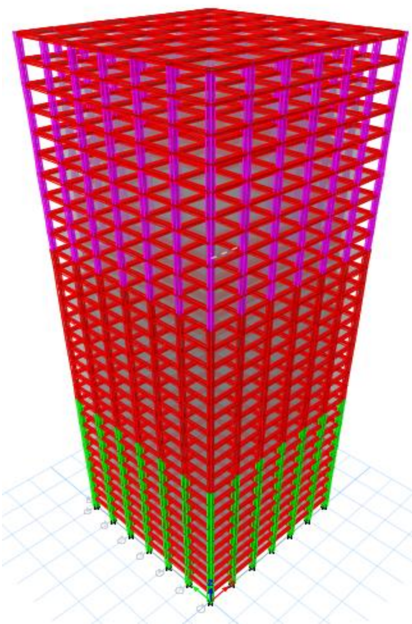
1.1.5 Outrigger with Belt Truss

In this System centrally located share wall core with the peripheral columns through deep girder at top at some intermediate level also, the lateral stiffness of multi-storey building can be highly improved. In steel buildings the core is made of vertical truss and outrigger is horizontal truss. These outriggers mobilize the axial stiffness of column in resisting the lateral load and simultaneously reduce the bending moment in column and beams.

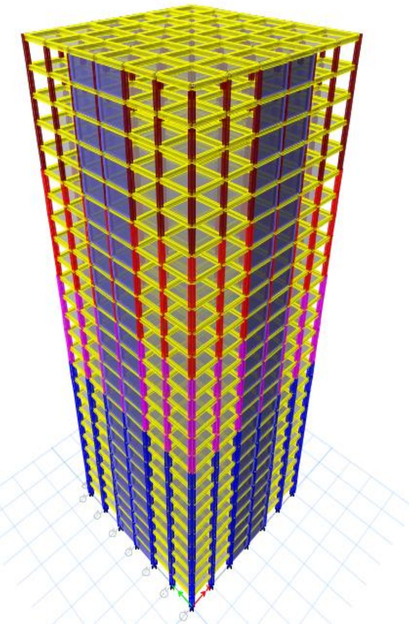
Numerical Study

The Plan of the building model are given below:
Model 1- Floor Plan of the Moment Resistance Frame.
Model 2- Floor Plan of the Moment Resistance Frame with Shear wall.
Model 3- Floor Plan of the Moment Resistance Frame with Bracing.

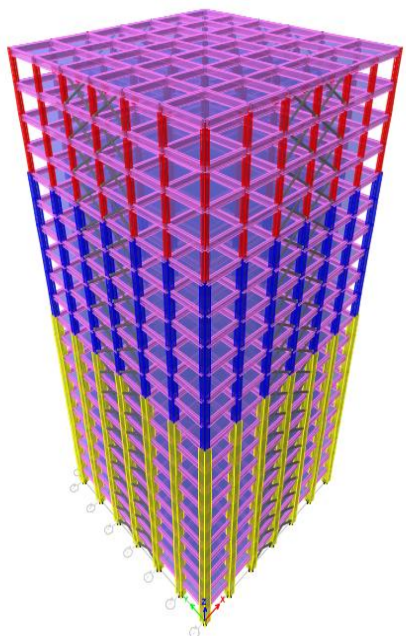
Model 4- Floor Plan of Frame tube with core.
Model 5- Floor Plan of Outrigger with belt truss.



Model 1



Model 2



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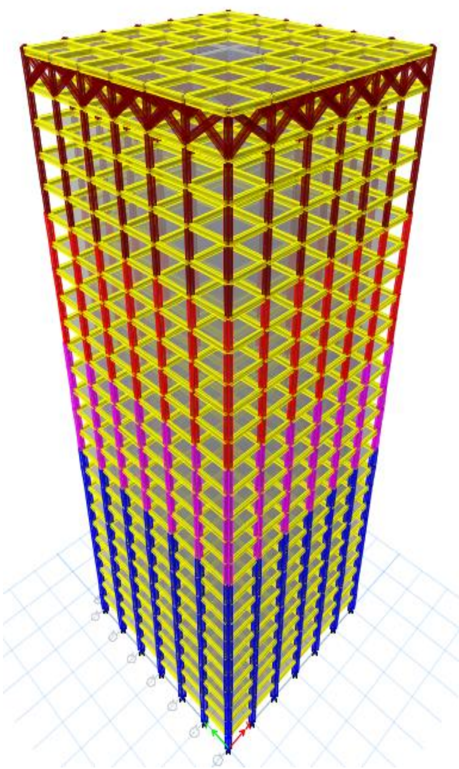
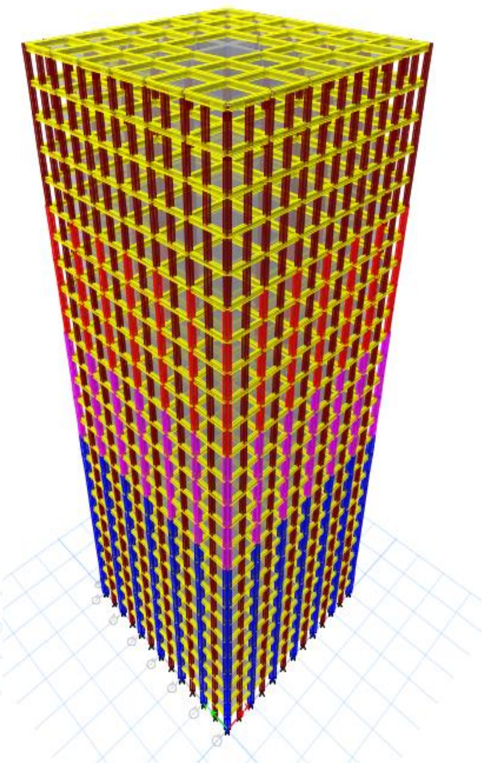


Model 4



Model 5

Fig,1 All Structural System ETABS 2015 Model

Table-1 Geometric Data

Geometric Data	
Plan dimension of bays : 30m × 30m	**Grade of Concrete** : M-20,25,30,35,40
Height of building: 30, 45, 60, 75, 90,105,120,135,150m (3.0m storey ht.)	**Density of concrete** : 25 kN/m3
Size of Column:381,450,530,600,685,762,900mm	**Density of Masonry** : 20 kN/m3
Size of Beam : 230 mm × 580 mm ,300 x 900mm	**Wall Load**: 13. 8kN/m, 6.9 kN/m
Slab Thickness :150 mm	**Live Load** : 2 kN/m2

WallThickness : 150,230mm	**Zone factor**: 0.16
Size of Bracing :91.5,110,5,120,150,170,200,mm	**Importance factor**: 5 (SMRF building)
Wind Speed : 39m/s	**Soil type**: medium soil
Terrain Category : 2	**Damping ratio**: 0.05 (5%)
Structural Class : B	**Time Period** : 0.09*h/Square root D
RiskFactor:1	**Topography Factor**(K3) :1

Result for 10 storey building comparison of Displacement & Storey Drift in X and Y direction.

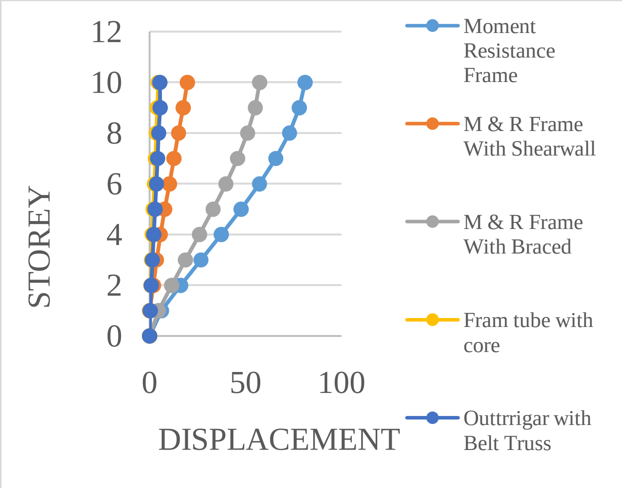


Fig. 2 displacement for 10 storey model

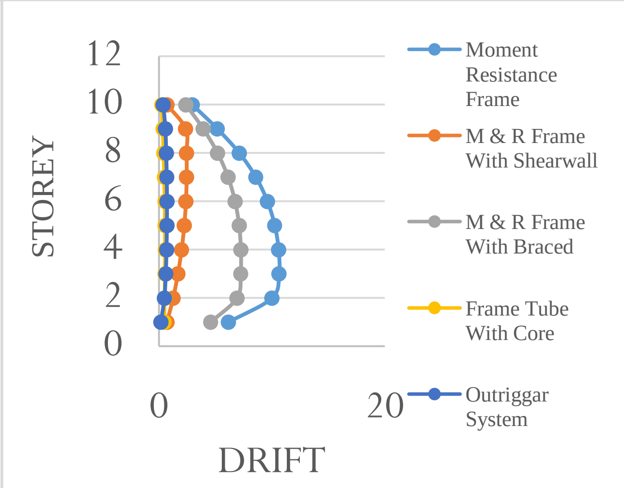


Fig. 3 storey drift for 10 storey model

Result for 20 storey building comparison of Displacement & Storey Drift in X and Y direction.

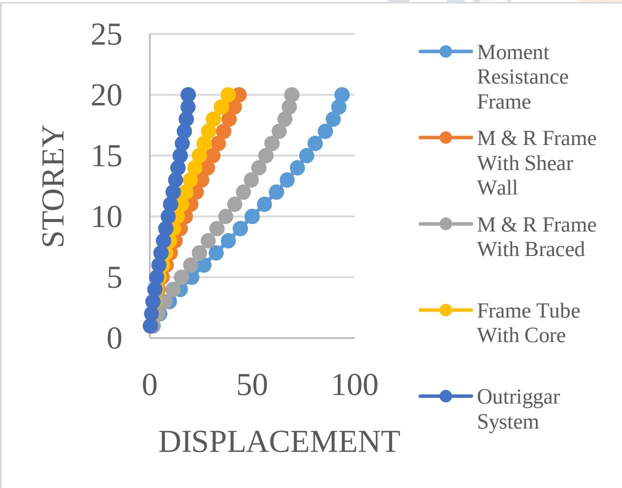


Fig. 4 displacement for 20 storey model

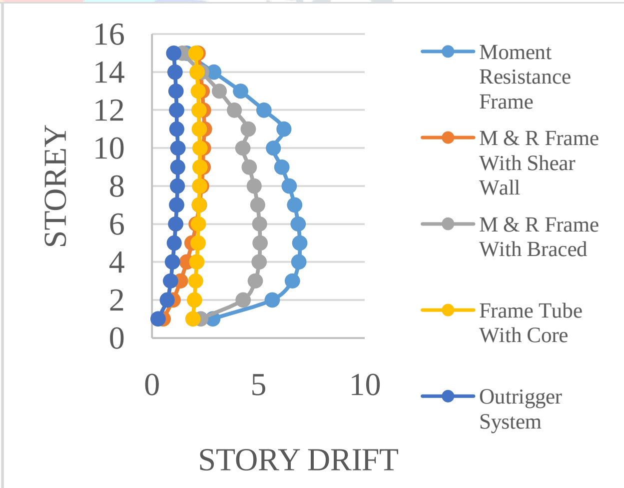
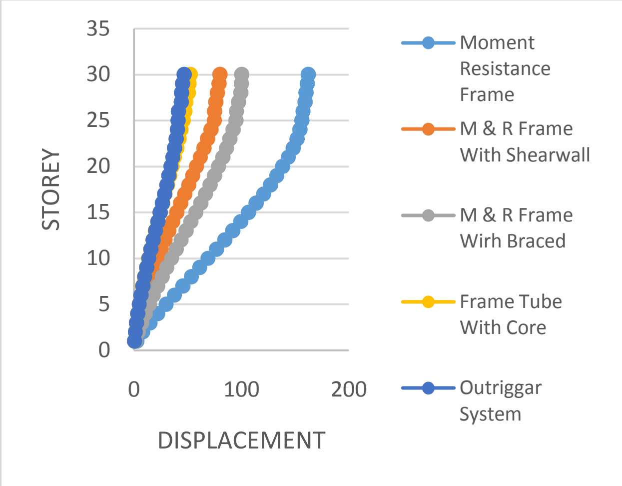


Fig. 5 storey drift for 20 storey model

Result for 30 storey building comparison of Displacement & Storey Drift in X and Y direction.



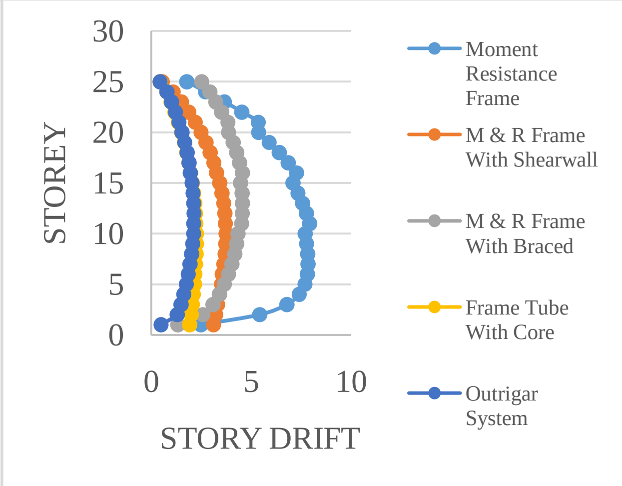
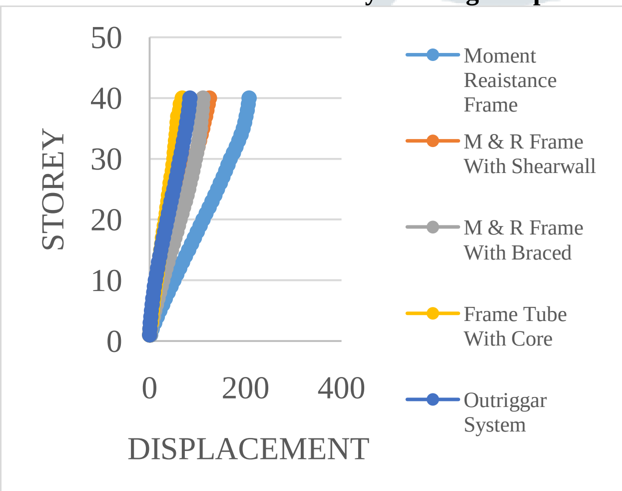


Fig. 6 displacement for 30 storey model **Fig. 7 storey drift for 30 storey model**

Result for 40 storey building comparison of Displacement & Storey Drift in X and Y direction.



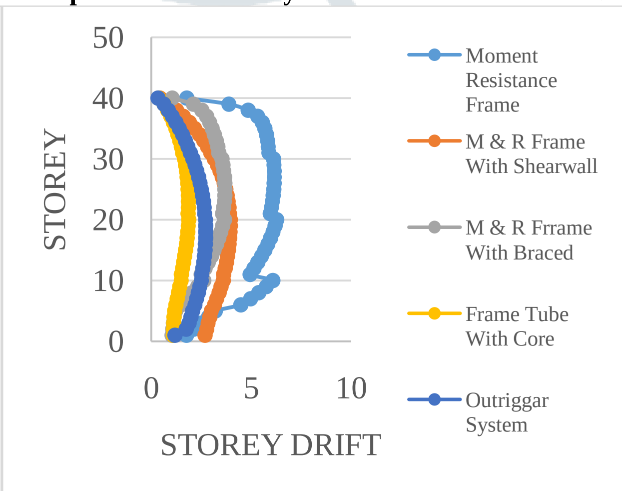
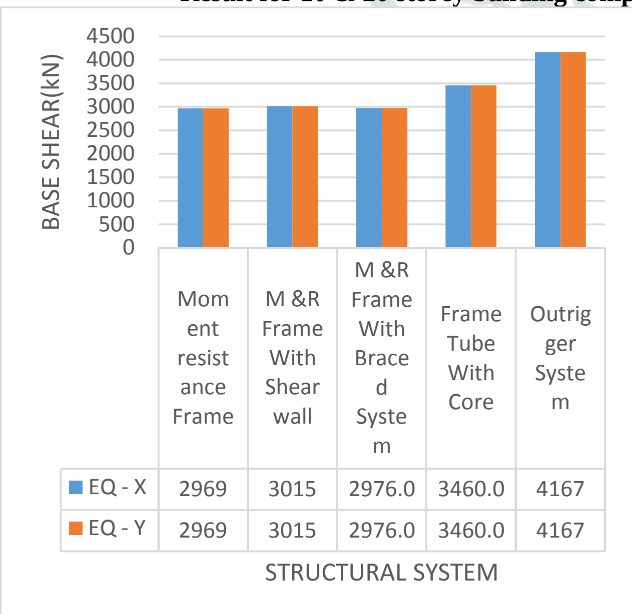


Fig. 8 displacement for 10 storey model **Fig. 9 storey drift for 10 storey model**

Result for 10 & 20 storey building comparison of Base shear EQ+ X and EQ +Y direction.



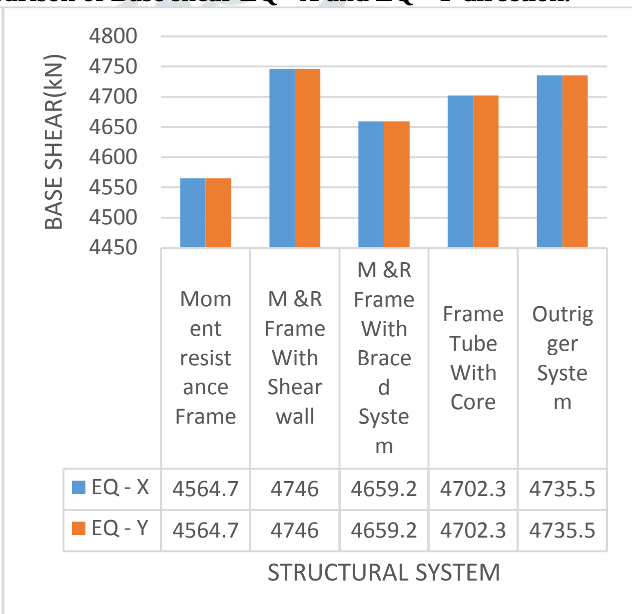


Fig. 10 Base shear for 10 storey model **Fig. 11 Base shear for 20 storey model**

Result for 30 & 40 storey building comparison of Base shear EQ+ X and EQ + Y direction.

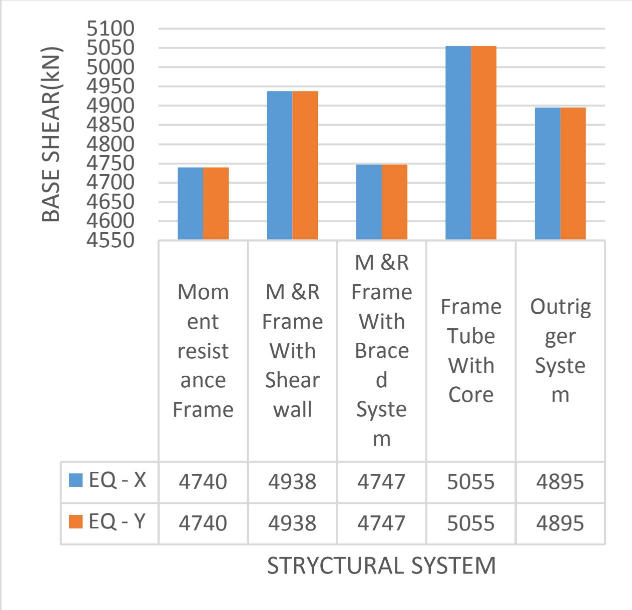


Fig. 12 Base shear for 30 storey model

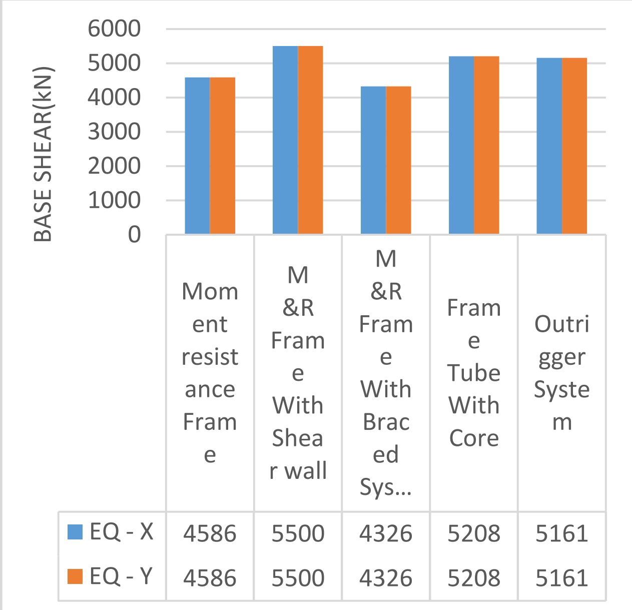


Fig. 13 Base shear for 40 storey model

CONCLUSION

$$\% = \frac{\textbf{Moment Resistance System} - \textbf{Other System}}{\textbf{Moment resistance system}} \times 100$$

- From the above graph result it is seen that
- The displacement &storey drift of moment resistance frame with shear wall system reduce by 75 % as compere to moment resistance frame system storey (10 to 20)
- The displacement &Storey drift of moment resistance frame with bracing system reduce by 54 % as compere to moment resistance frame system.
- The displacement &Storey drift of frame tube system reduce by 94 % as compere to moment resistance frame system.
- The displacement &Storey drift of outrigger system reduced by 96% as compere to moment resistance frame system.
- The displacement &Storey drift of moment resistance frame with shear wall system reduce by 30 % as compere to moment resistance frame with bracing system
- The displacement &Storey drift of frame tube with core system reduce by 60 % as compare to moment resistance frame with bracing system
- The displacement &Storey drift of outrigger with belt truss system reduce by 65% as compare to moment resistance frame with bracing system.
- The displacement &Storey drift of frame tube with core system reduce by 10% as compare to outrigger system.
- The displacement &Storey drift of moment resistance frame with bracing system reduce by 20% as compare to moment resistance frame with shear wall system (35 to 40) Storey building.

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