Comparison between Symmetrical and Unsymmetrical Building under Seismic Load Using Bracing and Shear Wall

Zain-Ul-Abdin Butt, Nitish Kumar Sharma, Nirbhay Thakur

***Abstract*: Structure engineering is a subset of civil engineering based on fundamental engineering. Physics laws and empirical database of the performance of various geometries and materials as it is directly approaches to the integrity, behavior and serviceability of the structure. The main emphasis of structure engineering is to transfers several forces along with the controlled utilization of any material or element under its serviceable conditions without any severe damage. It helps to make the structure safe, economic, durable and disaster resistant. Structures like roads, tunnels, buildings, power station, dams, bridges etc. are some of major successful outcomes of structural engineering for mankind and play an important part in services to the nation and its progress.**

***Index Terms:* Symmetrical and Unsymmetrical Building, Bracing and Shear Wall, U and L Type Shapes.**

I. INTRODUCTION

In the majority of analysis performed by engineers or structure designers are static that forces changes at such an accelerated way that it's almost considered as constant, succeeding no dynamic effects are taken up by them. But if the forces experienced by the structure is changing in such a way that inertial forces have substantial influence on the stability of the concerned structure, then such dynamic analysis is necessary to evaluate its actual performance under dynamic excitation so that analyst come to know about the essential requirements of structure to be safe and economical.

II. RESEARCH GAP

In the past research work, the authors had studied the different cases of shear wall and bracing in their particular studies. In the present study, research gap is covered with the efforts made to cover the two different range of comparative study cases of combination of bracings and steel bracings. The present was made to get the effective position of shear wall with bracing. Dynamic behavior of the structure was studied and comparison was made on the basis of parameters like base shear, time period, story drift and displacement at nodes.

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III. RESEARCH METHODOLOGY

In the present study, emphasis was made on the analysis of regular and irregular frames using Response Spectrum Method. A (G+9) building was modeled for the study. Different building frames were made incorporating shear walls and bracing of different shapes at different locations to have their effective position so that base shear can be reduced and to make structure earthquake resistant. The parameters on which the comparative study was made are: Base shear, Time period, Story drift and Displacement at nodes.

Table 1: Specifications of the regular building

Specifications	Data
Story Height	3.0m
No. of bays along X direction	3
No. of bays along Z direction	4
Bay Length along X direction	6m
Bay Length along Z direction	6m
Concrete grade used	M 40
Columns	0.50m X 0.30m
Longitudinal Beams	0.40m X 0.25m
Transverse Beams	0.30m X 0.25m
Slab Thickness	0.15m
Unit Weight of Concrete	25 kN/m^3
Live Load	4.0 kN/m^3
Type of building	General Building (I=1)
Type of soil	Medium Soil
Response Reduction factor	5
Damping ratio	5%
Bracing	ISHB300
Zone	IV

3.1 Following are Various Study Cases Enrolled in the Thesis

Case 1: RC Regular Frame Structure

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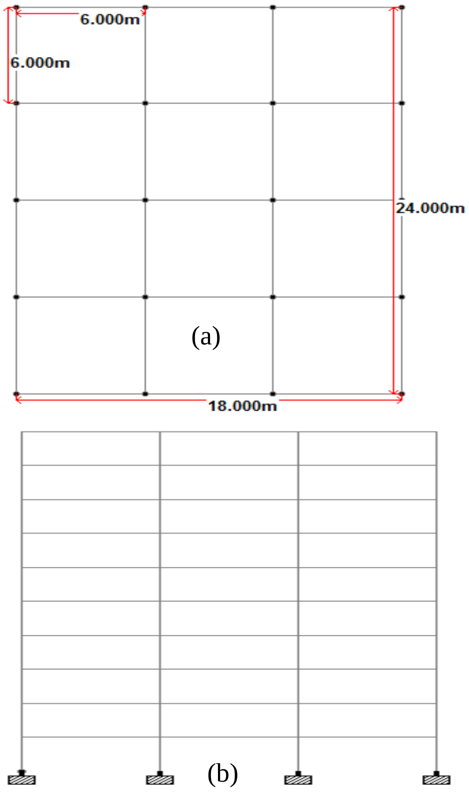

Fig. 1 Plan and Elevation of Regular Bare Frame

Case 2: RC Irregular Frame

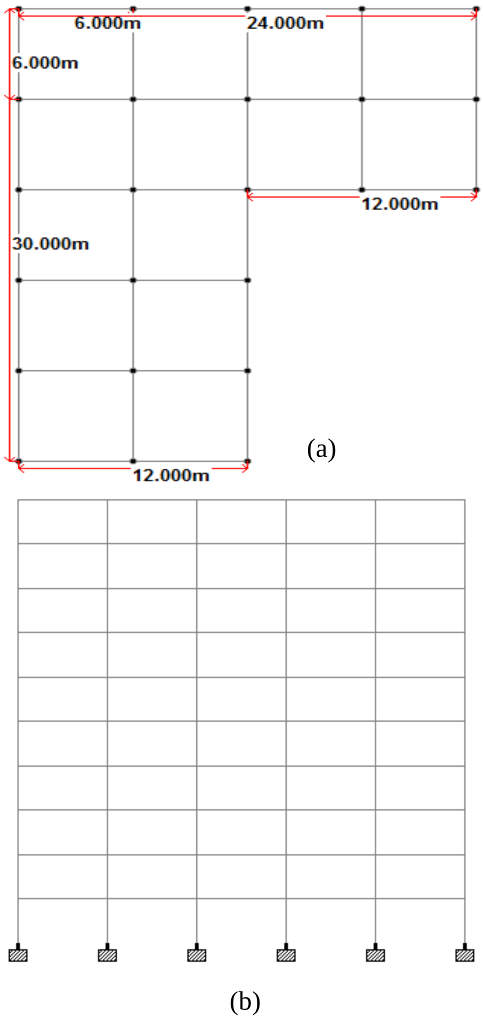

Fig. 2 Plan and Elevation of Irregular Bare Frame

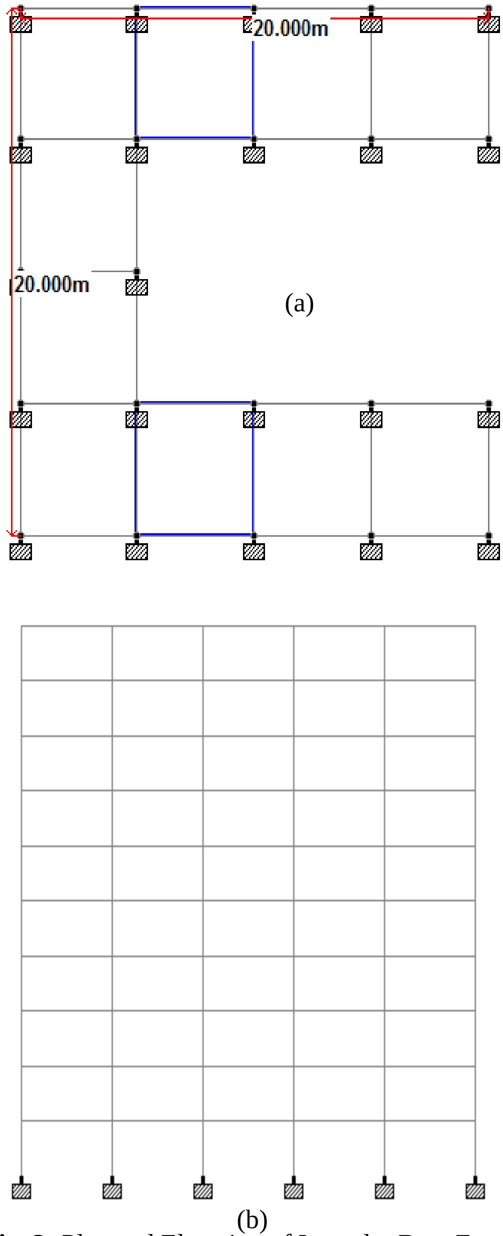

Fig. 3: Plan and Elevation of Irregular Bare Frame

IV. RESULTS AND DISCUSSIONS

The following chapter deals with the results obtained from the frame structures of different configurations, when they were subjected to seismic excitations. The results include base shear, story drift and displacement at nodes. Comparison was made between the regular and irregular frame structures.

Table 2: Case 1 RC Frame Structure

Parameters	Displacement (mm)	Storey Drift (mm)	Base Shear (kN)
Regular Frame	254.184	0.008853	2546.84
L shape Frame	310.754	0.012578	2785.41
U shape Frame	299.245	0.011025	3158.79

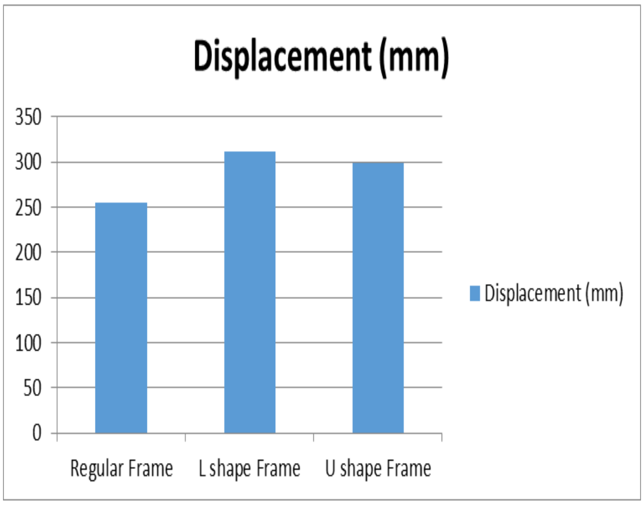

Fig. 4 Graph Representing Displacement Values for Regular and Irregular Frames

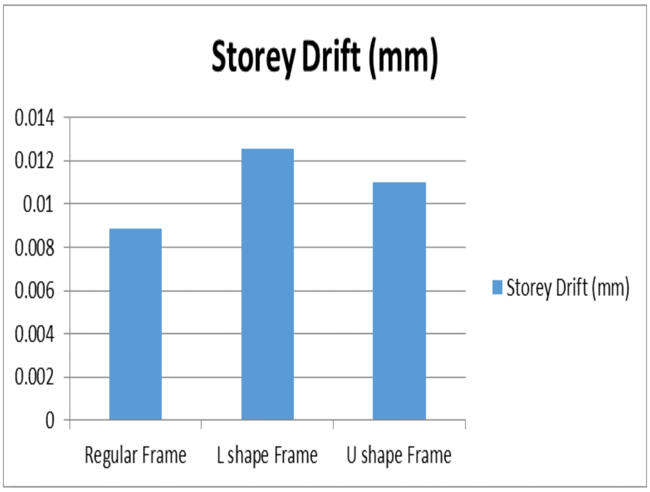

Fig. 5 Graph Representing Storey Drift for Regular and Irregular Frames

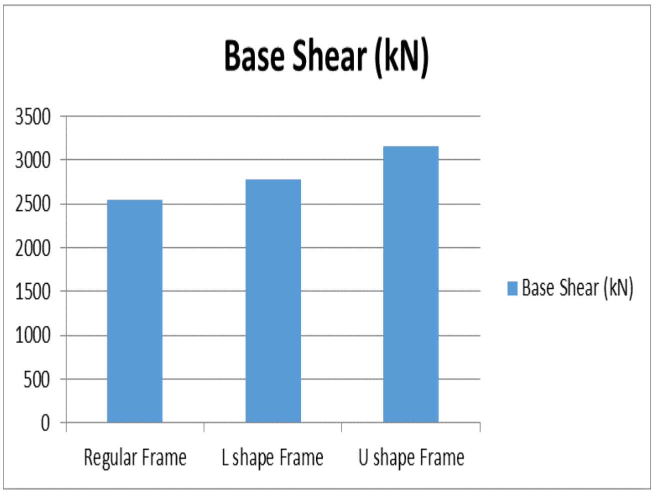

Fig. 6 Graph Representing Base Shear for Regular and Irregular Frames

Case 2: RC Frame Structure with Combination of Shear Wall and composite Bracing Systems

Table 3: Representing Displacement Values for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Types	Displacement (mm)	
	Regular Frame	Irregular Frame
Diamond-Core	63.139	94.708
X-Core	75.448	113.172
Diagonal-Core	93.308	139.962

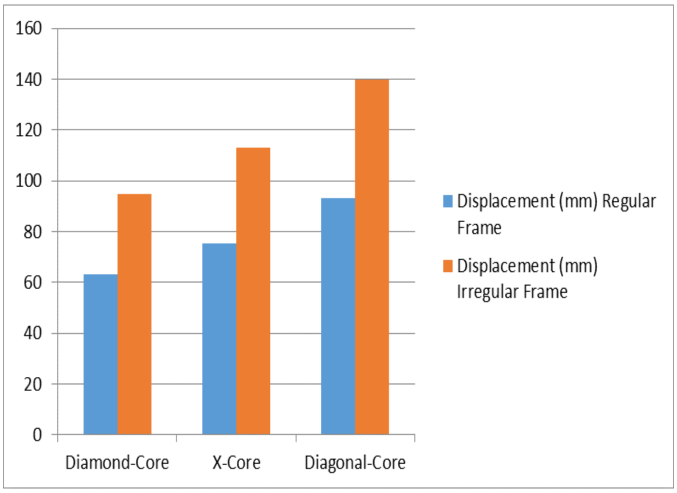

Fig. 7 Graph Representing Displacement Values for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Table 4: Representing Storey Drift for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Types	Storey Drift (mm)	
	Regular Frame	Irregular Frame
Diamond-Core	0.001325	0.001988
X-Core	0.001687	0.002531
Diagonal-Core	0.002356	0.003535

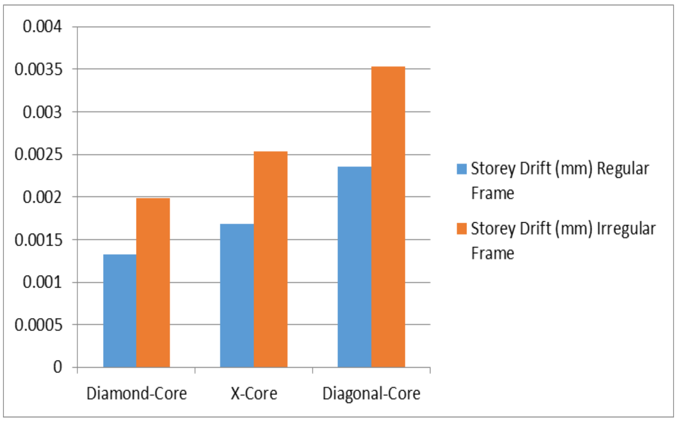

Fig. 8 Graph Representing Storey Drift for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

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Table 5: Representing Base Shear for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Types	Base Shear (kN)	
	Regular Frame	Irregular Frame
Diamond-Core	6608.151	9912.227
X-Core	6831.164	10247
Diagonal-Core	5648.425	8522.136

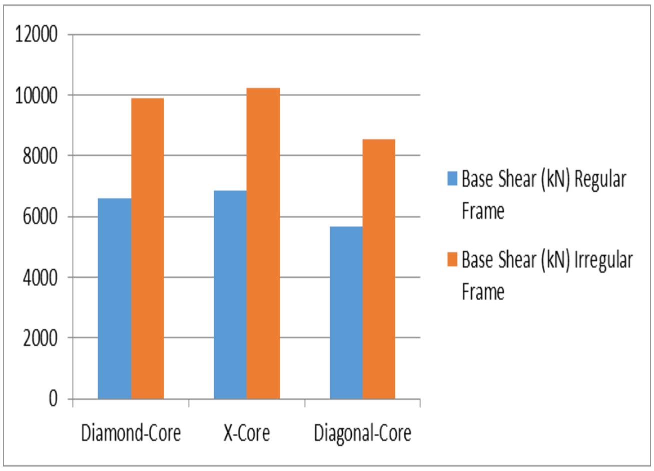

Fig. 9 Graph Representing Base Shear for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Table 6: Representing Displacement Values for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Types	Displacement (mm)	
	Regular Frame	Irregular Frame
Diamond - SW Edges	88.76	125.442
X - SW Edges	96.4695	133.14
Diagonal - SW Edges	91.754	128.394

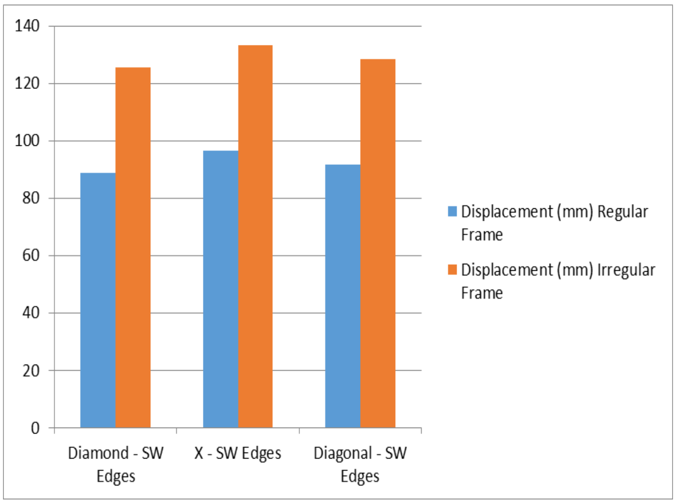

Fig. 10 Graph Representing Displacement Values for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Table 7: Representing Storey Drift for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Types	Storey Drift (mm)	
	Regular Frame	Irregular Frame
Diamond - SW Edges	0.001247	0.002547
X - SW Edges	0.001489	0.003871
Diagonal - SW Edges	0.002047	0.004178

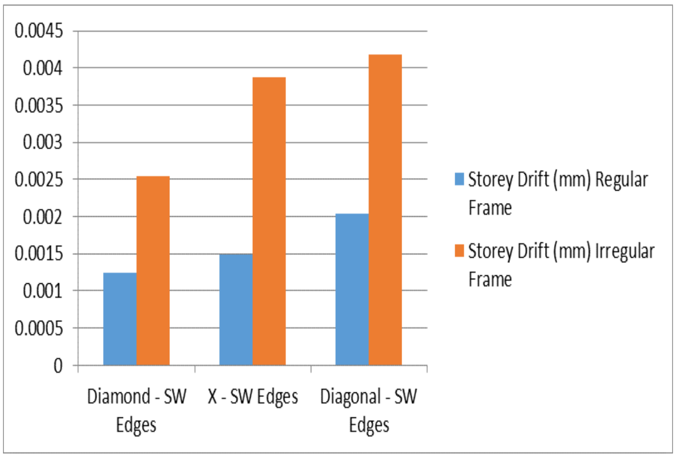

Fig. 11 Graph Representing Storey Drift for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Table 8: Representing Base Shear for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

Types	Base Shear (kN)	
	Regular Frame	Irregular Frame
Diamond – SW Edges	6917.258	11542
X - SW Edges	6602.149	8354.789
Diagonal - SW Edges	6845.214	9987.157

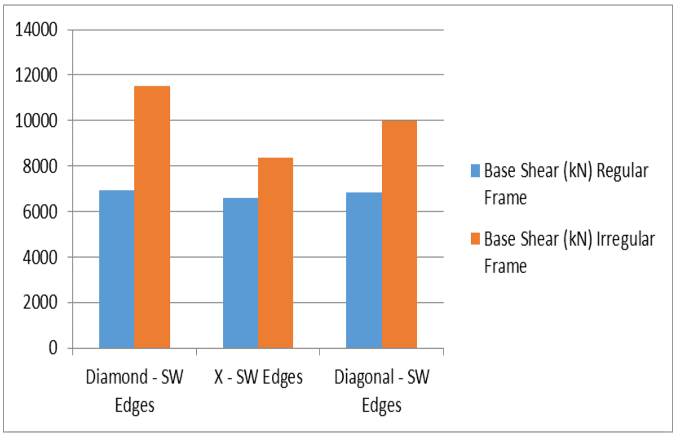

Fig. 12 Graph Representing Base Shear for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

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Table 9: Representing Time Period for RC Frame Structures Composed of Shear Wall and Bracings

Types	Time Period (sec)		
	Regular Frame	L shape Frame	U shape Frame
Diamond-Core	0.242	0.923	0.625
X-Core	0.513	1.36	1.24
Diagonal-Core	0.911	1.69	1.44
Diamond - SW Edges	0.744	1.49	1.24
X - SW Edges	0.832	1.54	1.36
Diagonal - SW Edges	0.828	1.52	1.44

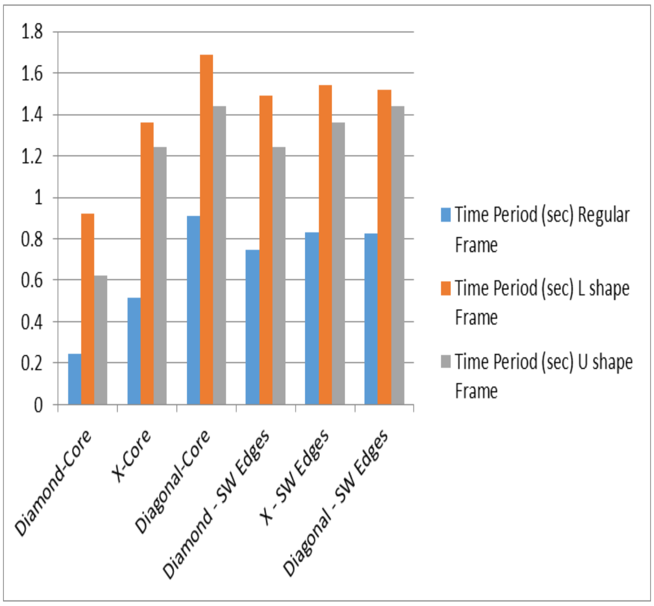

Fig. 13 Graph Representing Time Period for Regular and Irregular Systems for Various Composite Bracing and RC Shear Wall Systems

V. CONCLUSION

Case 1: RC Frame Structure: Bare RC frame structures, regular ad irregular in plan were analyzed for dynamic analysis in Staad Pro V8i. It was found that the there is great significance in comparing the results of them on the basis of base shear, storey drift and displacement at nodes. The displacement was calculated for regular frame as 254.184mm, whereas for irregular frame was calculated as 310.754mm. The storey drift was calculated for regular frame as 0.008853mm, whereas for irregular frame was calculated as 0.012578**.** The base shear was calculated for regular frame as 2546.84 kN, whereas for irregular frame was calculated as 3158.79 kN.

Case 4: RC Frame Structure with Different Shear Wall System and Composite Bracings: For this particular case, separate combinations were made of bracing and shear wall so as to have better results for comparison purposes between bare frames, isolated shear walls and isolated bracings. From the results, it has been found that the least displacement was observed in diamond bracing with core shear wall as 63.139mm and least was observed in diagonal bracing with core shear wall. Similarly, as of storey drift, diamond core has best results as 0.001325mm as compared to diagonal core shear as 0.002356mm.

But diamond racing with shear wall at edges showed displacement as 88.76mm as compared to irregular frames as 125.442mm. So, on comparison, it could be said that diamond bracing with core shear wall was proved to be better. Similarly, as of storey drift, diamond core has best results as 0.001247mm as compared to diagonal core shear as 0.002047mm.

But diamond racing with shear wall at edges showed base shear as 6917.258kN as compared to irregular frames as 11542kN. So, on comparison, it could be said that diamond bracing with core shear wall was proved to be better.

VI. FUTURE SCOPE

In this research, focus was made on linear dynamic analysis for seismic excitation. But, non-linear dynamic analysis can also be performed on the frame structure for precise evaluation of results. So, non-linear time history analysis can also be performed. Also there can be option for wind analysis.

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