STUDY OF SEISMIC PERFORMANCE OF OPEN GROUND STOREY BUILDING STRENGTHENED WITH REINFORCED CONCRETE SHEAR WALL

[1]Dharamraj Shrivas, [2]Prof. Kapil Soni, [3]Dr. Sharad Kumar Soni
[1]Research Scholar, [2]Assistant Professor, [3]HOD
Department of Civil Engineering
Rabindranath tagore University, Raisen

Abstract - The idea of open ground storey (OGS) building has been introduced mainly because of the need for parking in urban localities. Due to the special feature of providing parking facility in the ground storey of this building, a large number of open ground storey buildings have been built and accommodated especially for residential purposes throughout the different cities of the country. Shear wall has high in plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads. To improve the seismic performance of open storey building an attempt is made to analyse the multi-storey buildings with and without shear walls. The performance of the building with various configurations of shear walls was studied. For all shear walls configurations under considerations the length of shear wall in two principal directions in plan is kept equal. The RCC building models having G+15 storeys with shear walls and without shear walls are considered for the study. Seismic analysis of building is carried out using structural engineering software StaadPro V8i (SS4) and the seismic performance of building with various shear walls configurations is compared with respect to parameters like base shear, lateral displacement, time period and member forces.

Keywords: Shear wall, open storey, Base Shear, Staad Pro,Seismic performance

1. OPEN GROUND STOREY BUILDINGS

Open floor buildings (also known as soft floors) are found mainly nowadays in the metropolitan area because they have the most available parking space. The soft-storage impact in this form in building is comparatively more prone to fall during the earthquake. At the first-floor level, large lateral movements are induced which create large curvatures in the columns of the building. The bending moments and the shear forces are often magnified in these columns in contrast to a bare system (without a smooth floor).The energy generated by the earthquake loading is dissipated by the vertical resistance elements on the ground floor that induce plastic deformations that turn the ground floor into an unavoidable structure. When not built correctly and with due caution, the building of an open floor is quite risky. The concept of open ground storey (OGS) was primarily implemented because parking was required in urban areas. Because of the unique feature of providing car parks on the ground floor of this house, a large number of open buildings have been built and hosted particularly in the numerous cities of the country for residential purposes. For reality, if the columns in a building built from concrete have not been opened up as the partition wall that divides them into a parking lot, then this form in construction should be viewed as an open floor or soft level house. In other terms, this forms the right framework.

These constructions are categorized by
(a) The obvious absence of unreinforced brickwork infill in the ground level, and existence of the same in all levels above;
(b) The usage of lone breakable (230x450) mm columns with narrow non-yielding reinforcement detailing arrangement; and
(c) The nonappearance of some structural grid in plan of the construction, and some anomalies in the structural systems in altitude.
The sheer force usually rises downwards throughout the height of the structure; at the base of the building it is maximum. This means that the house has to be better downwards. However, that is not assured by the tradition of open-plan houses. The behaviour varies dramatically from the concept of the pure-frame layout, which is recognized in design experience, for an unreinforced masonry structure.

2. BASIC ASPECTS OF SEISMIC DESIGN

In addition to building rigidity, the mass of the structure is built to regulate the seismic design because the earthquake produces an inertia force proportional to the mass of the building. The design construction to perform elastically during shakings without damage may render the project cost-effective. As a concern, damage may be done to the structure and there by dissipate energy supplies when the earthquake happen. Hence conventional earthquake-resistant creation philosophy that general structure could be able to resist (Figure 1.1):
a) Slight and frequent shaking with no destruction to structural and non-stuctural components;
b) Reasonable shaking with minor destruction to structural components, and some destruction to non-structural components;
c) Severe (and infrequent) shaking with destruction to structural components with no failure (to protect life and property adjoining the construction).

Buildings are thus designed for just a fraction (~8 to 14 per cent) of the force they would encounter if they were to stay elastic during the powerful earthquakes (Figure 1.4) and cause damage (Figure 1.2). In order to prevent structural loss during minor shocks, however, adequate initial rigidity is important. Therefore Seismic strategy balances and cost-effective and tolerable structural destruction make the project workable. This cautious balance is reached on the basis on research and detailed post-earthquake destruct analysis. This knowledge is richly converted into detailed regulations on seismic architecture. Structural disruption to construction wind forces is not appropriate. For this cause, earthquake-resistant strategy(design) is named and not earthquake-proof design.

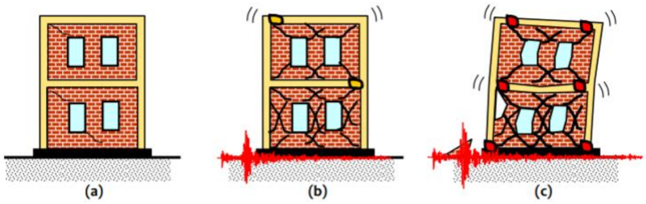


Fig 1 Earthquake-Resistant Design Philosophy for buildings: (a) Slight (Frequent) Shaking – No/Hardly any damage, (b) Resonable Shaking – Minor structural damage, and some non-structural damage, and (c) Severe (Infrequent) Shaking – Structural destruction, but NO collapse

3. EARTHQUAKE-RESISTANT DESIGN METHODS

Perfect lateral load distortion curve of a structure under monolithic lateral movement loading in pushover investigation reflects three main characteristics: linear action, non-linear action, and flexible behaviour (fig.1.3). Such characteristics may be used to identify three dominant fields of structural behaviour, that is elastic, primary inelastic and ductile inelastic steps. The inelastic energy dissipation potential of this building is asignificant product of all these three characteristics.

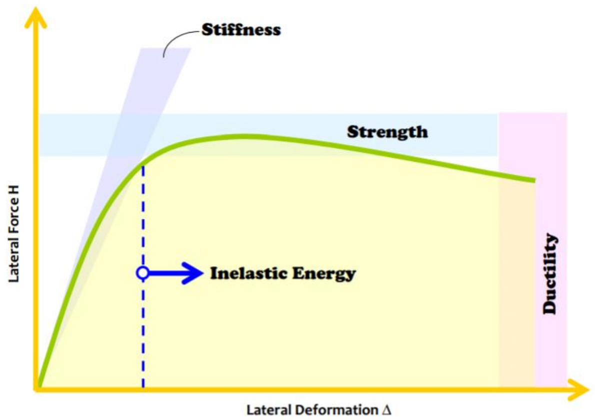


Figure 2: Four Earthquake-Resistible Building Virtues govern buildings' earthquake performance: steadiness, power and ductile nature affects the load-deforming nature of buildings specifically, while the Structural Seismic Structure implicitly controls these three virtues

4. METHODOLOGY

The shear wall has a strong strength, rigidity and tolerance to massive horizontal loads concurrently and to withstand forces of gravity. The effort is made to study multi-floor buildings with and without shear walls to enhance seismic efficiency in open-plan buildings. It was analyzed the efficiency of the building with different shear wall arrangements. In each shear walls the length of the shear wall is the same in two different directions. The G+ 15 storey with shear walls and withoutshear wall RCC structure are being used for study. The analysis is conducted on design software StaadPro V8i (SS4) and the seismic functioning of structure with various shear walls is relate with parameters such as base shear, lateral displacement, time period and the element forces.

STRUCTURE AND ANALYTICAL MODEL

The layout consists of RCC building of G+ 15 floors and has “six bays with a bay width” of 3.5 m in each direction. The height of the each storey is 3.1 and 1.5 m for both floor and plinth respectively. A beam and column with measurements 0.3 m x 0.5 m and 0.45 m x 0.45 m are given in the RCC frame . The slab is estimated to be 120 mm deep. The templates are checked using the shear wall or not. As seen in the figure 3.1, the models considered for this analysis. M20 quality concrete and Fe 415 type steel are being used.

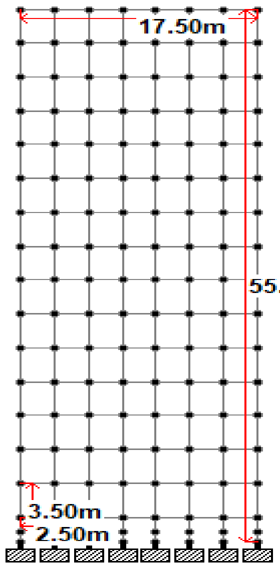


Fig. 3: Building frame on levelled ground

Table 1: Building description

S.no	Specification	Plain
1	Plain dimensions	24.5 x 17.5 m
2	Length in x- direction	24.5 m
3	Length in z- direction	17.5 m
4	Floor to floor height	3.1 m
5	No. of stories	16
6	Plinth level	1.5 m
7	Soil type	Hard
8	Seismic zone	4 & 5
9	Grade of concrete	M 20
10	Grade of steel	Fe 415
11	Beam size	0.3 x 0.5 m
12	Column size	0.45 x 0.45 m
13	Shear wall location	Straight, C shape, Corner and all (Straight, C shape, Corner)

LOADS
1) Dead loads
Self-weight dependent on sectional properties and content constants is determined with software. Despite this superimposed dead load on all floors owing to floor finishing or water protection and also the load of wall lay over on beams.
Dead load on floor = 5 kN/m2
2) Live Loads
"Live load on floor" = 4 kN/m2

5. MODELING AND ANALYSIS

The design is modelled with the StaadPro V8i (SS4) finite element software. Beams and columns are based on each node as an aspect of two node beams with six degrees of freedom. The slab are constructed in compliance with rigid membrane elements and diaphragm control. The area loads on the slab are added. Construct model as a bare structure, but an evenly spread load on beams is the dead weight of the infill. The shear walls are modelled using the broad column analogy framework and all shear walls and columns are supported by fixed supports. The specific shear wall structures in figure 4 to fig. 7 are chosen to enhance the seismic reaction. In every location of shear wall model is hold to keep structure symmetric along all the major axes to avoid torsion. Dimension of "Shear walls" and number of columns in both directions are similar such that the layout is symmetrical in both major directions of the design.

INVESTIGATION WITH STAAD PRO
The STD input file includes a form of sequential instructions. The instructions provide commands or "data" for review and/or "design". This form of "file" is "created" or can be edited through a text editor tool or "GUI" Modelling functionality. Every text editor for editing / creating the input STD file can be used for this intent. The Interface Modelling functionality generates the "input file through collaborating" procedure-driven menu graphics.

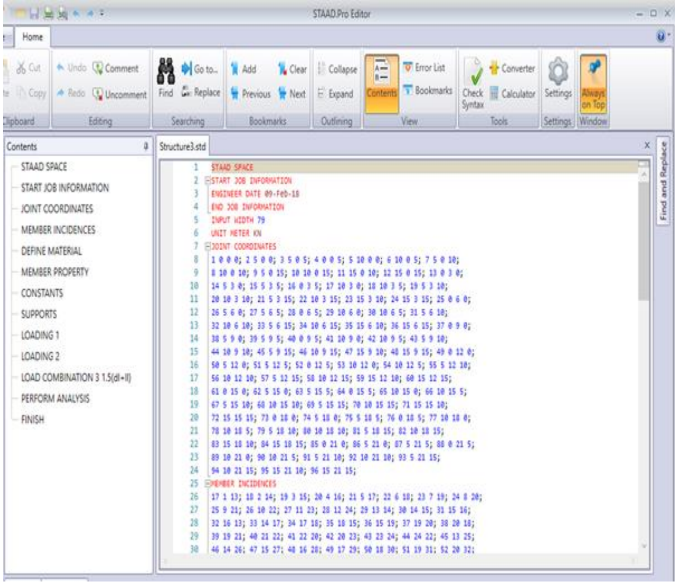


Fig. 4: STAAD input file

6. RESEARCH FINDINGS

The findings of this analysis are grouped into two following categories: -
The findings from this seismic analysis of single-building are seen in Fig. The results are described of different versions 5.1-5.5 for various.
1) Base shear
Table 2: Base shear results

	Zone = 4	Zone = 5
Models	Base shear (KN)	
Model 1	2648.11	4020.31
Model 2	4001.71	5213.23
Model 3	2220.47	3333.44
Model 4	4461.64	5175.36
Model 5	3155.22	3678.74

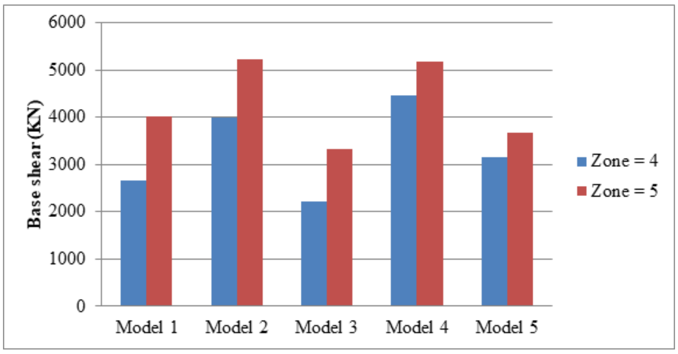


Fig. 5: Variation of base shear

Results from this analysis demonstrate that the introduction of shear wall into the RCC frame raises the base shear by growing lateral rigidity. The time span of the system often decreases, and lateral framework displacement decreases substantially. Thus, it can be claimed that as we shift zone 4 to zone 5, the addition of the shear wall enhances the base shear impact of this impact. The minimal value of the base shear of zone 3 (C-shape) Zone 4 and Zone 5 is like the other shear wall configurations.

2) Fundamental time period

Table 3: Fundamental time period results

Models	Zone = 4	Zone = 5
	Time period (Sec)	
Model 1	3.03	4.24
Model 2	1.42	2.56
Model 3	2.34	3.38
Model 4	1.87	2.27
Model 5	1.40	2.36

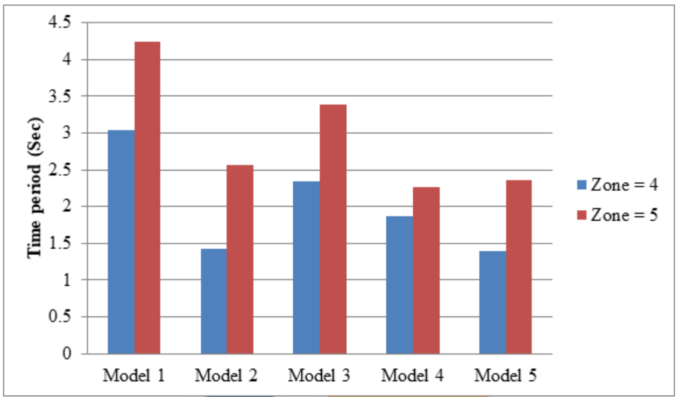


Fig. 6: Variation of time period

Both versions of shear walls have a time-frame of about 60% less than Model 1. In both zone 4 and Zone 5, Model 2 (C form) has minimum time period.

3) Member forces

The shear forces and flexural moments in the columns are minimized by the shear wall the same as the pattern on a levelled surface. The member forces are as , axial strength, shear forces and flexural moment are shown in Fig. 5.3, 5.4 and 5.5 respectively.

Table 4: Axial force results for structure

Models	Zone = 4		Zone = 5	
	Axial force (KN)			
	Max Fx (in kN)	Min Fx (in kN)	Max Fx (in kN)	Min Fx (in kN)
Model 1	1228.99	-6.205	1848.49	-17.77
Model 2	1561.52	-512.19	2312.11	-800.40
Model 3	1057.07	-345.32	3129.61	-638.85
Model 4	2804.59	-1012.41	2804.59	-1428.36
Model 5	2255.89	-738.60	2580.85	-1063.59

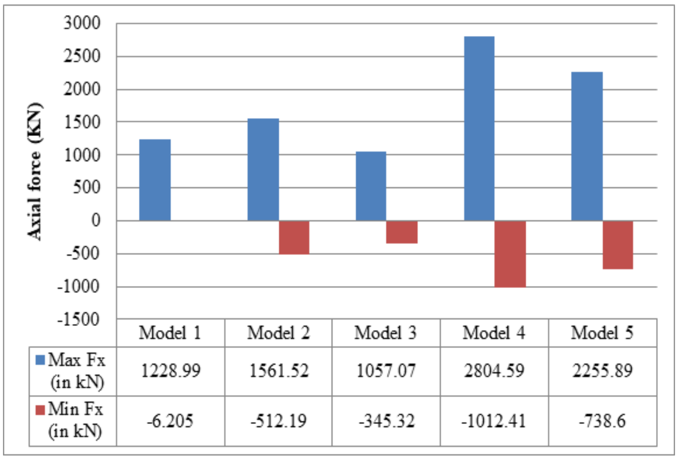


Fig. 7: Axial forces in column for building for zone 4

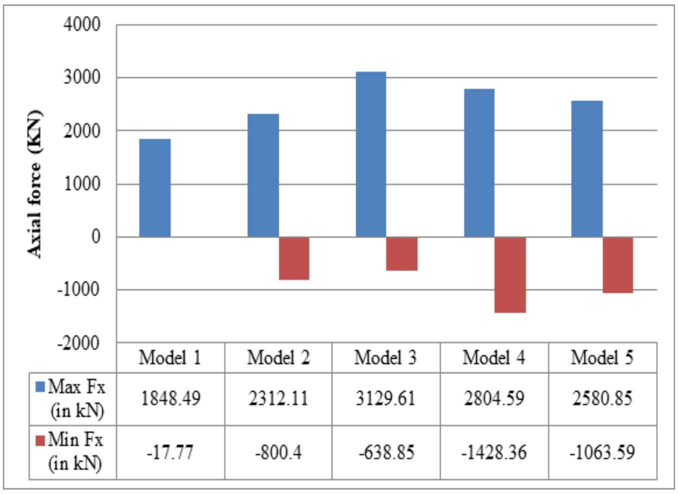
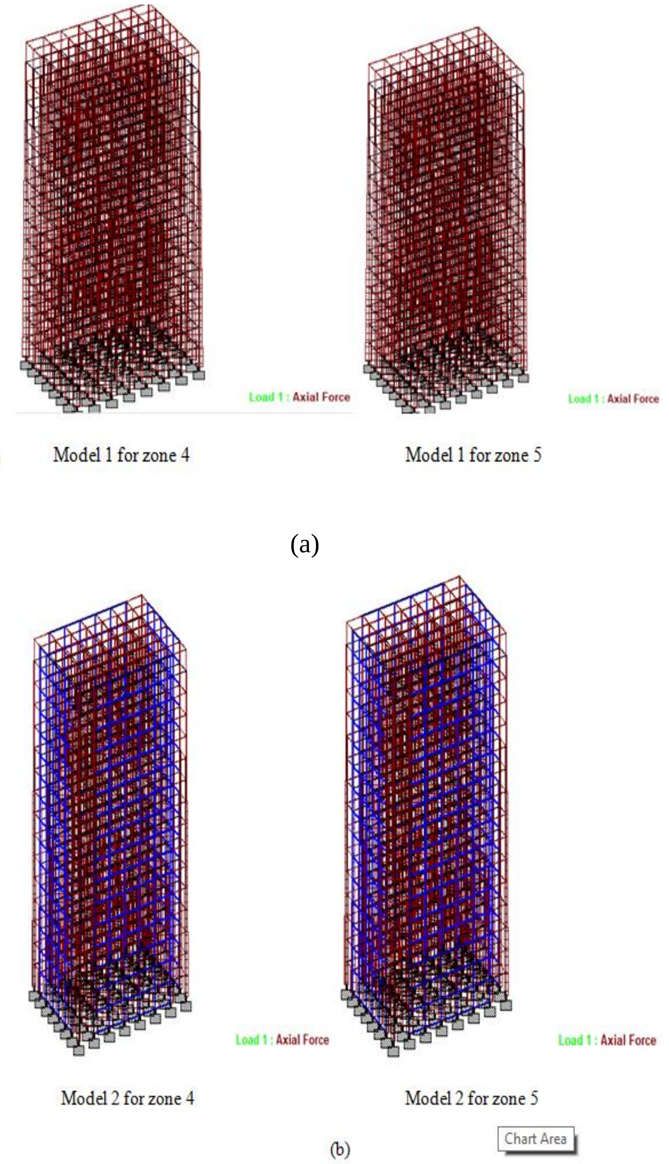


Fig. 8: Axial forces in column for building for zone 5

It is perceived that extreme axial forces are realized in model 1 for zone 4 and zone 5. From all the models, model 3 shown min. axial forces for zone 4 and zone 5.



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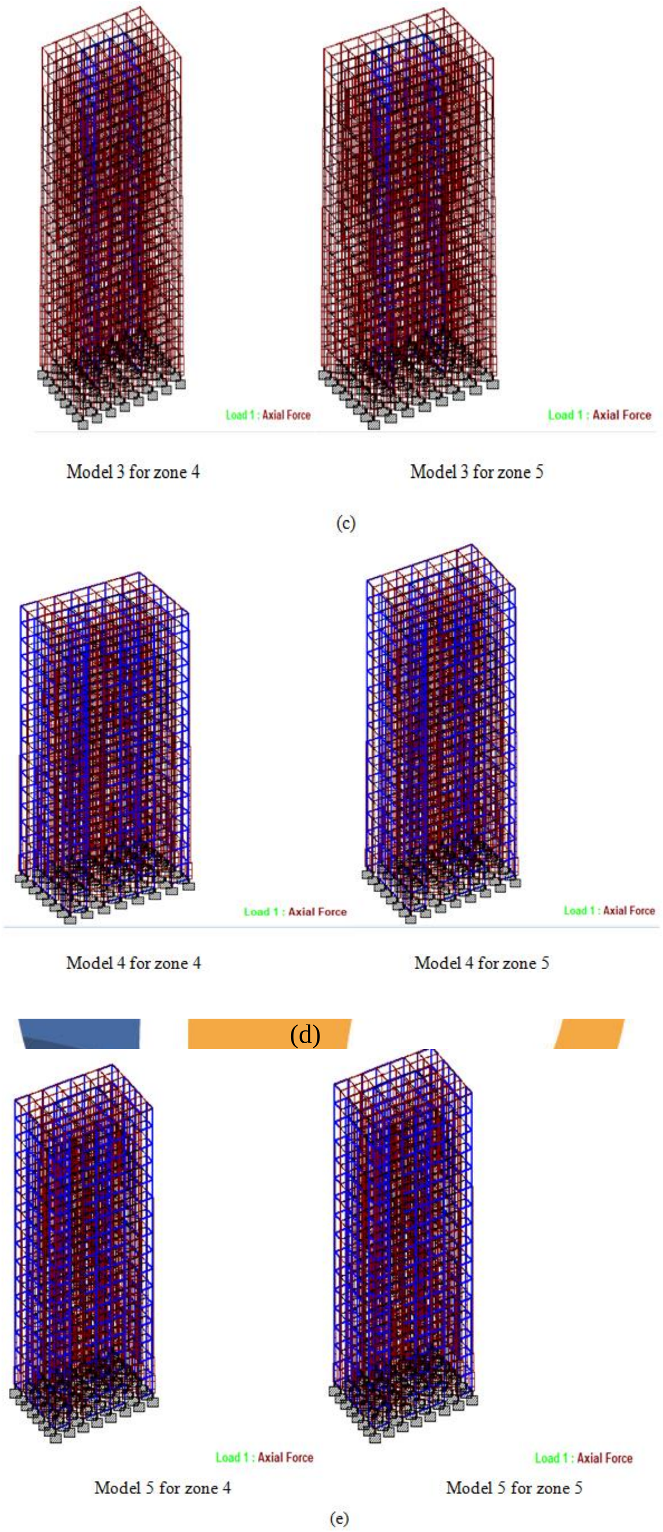

Fig.9 Axial forces in structures for plain ground

7. CONCLUSION

From the above discussion following conclusions can be made:

The findings of this thesis are provided in numerous models for seismic performance of buildings on plain ground are presented in various models:

1. Results from this analysis demonstrate that the introduction of shear wall into the RCC frame raises the base shear by growing lateral rigidity.
2. The structure time span is shortened and the lateral framework displacement is therefore considerably reduced. That is why, as we adjust Zone 4 to Zone 5, the addition of the shear wall raises the base shear.
3. The minimal value of base shear is seen in model 3 (C-shape) for the zone 4 and zone 5 in all other shear wall configurations.
4. All the versions with shear walls have approximately time-span of about 60% less than Model 1. Model 2 (C form) has the less time span for both zone 4 &5.
5. It is observed that maximum axial forces are seen in model 1 for zone 4 and zone 5. From all the models, model 3 shown min axial forces for zone 4 and zone 5.
6. It is observed that maximum shear forces are seen in model 2 for zone 4 and zone 5. From all the models, model 3 shown min shear forces for zone 4 and zone 5.
7. It is observed that maximum flexural moments are seen in model 2 for zone 4 and zone 5. From all the models, model 3 shown min shear forces for zone 4 and zone 5.
8. Hence in case of plain ground building with C-shape shear wall perform best.

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