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STUDY ON THE EFFECT OF DAMAGE LOCATION AND SEVERITY ON DYNAMIC BEHAVIOUR OF MULTI-STOREY RC FRAME STRUCTURE"

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Abstract : Damage is defined as modifications to a systems physical property that have a negative impact on the structural performance now and in the future. This happens for either natural or artificial reasons. In the present work, the dynamic behavior of undamaged and damaged RC multi- story structures is studied with different damage locations in beams and columns at different levels (stories). The damage is introduced by reducing Young's modulus of concrete by 35%, 45%, 55%. The critical damage level is identified by using modal analysis. And the damage severity in the columns and beams varied 35 % to 55% in different model. The modal analysis and lateral load analysis are carried out to understand the dynamic behavior of damaged structures. Earthquake load is considered a lateral load. The equivalent Static method is considered for analysis as per IS 1893 (Part -1): 2016 code provisions. The time periods of a structural system are dynamic parameters that vary when damage of a specific severity occurs at a particular location. This variation is due to alterations in the structural integrity caused by damage, affecting the system's response to external forces and potentially compromising its stability and safety. The introduction of damage at a specific location and of a certain severity within a structural system can lead to changes in the system's displacements. This alteration occurs as the damaged components may no longer provide the same resistance to deformation, resulting in shifts in the overall displacement patterns of the structure

1. Introduction

1. Damage and its causes

Damage is described as changes made to a system, whether deliberate or inadvertent, that have a negative impact on the system's current or future performance. These systems can be natural or artificial. These systems may not show the negative effects of this event for many years, if not generations, depending on the levels of exposure. The concept of damage is not meaningful without a comparison between two different states of the system, one of which is assumed to represent the initial, and often undamaged, state, as implied in this definition of damage (Doebling et al., 1998).Concrete damage can be divided into four categories based on the primary factors that causes the damage are Physical, chemical, biological, and mechanical

Physical Factors: This includes heat, change in temperature, wind, moisture, etc. The physical causes are mainly category are Abrasion, erosion, and surface wear cause mass loss.

- Cracking caused by regular temperature and humidity gradients when exposed to high temperatures by fire. And the salt crystallization in pores due to freezing causes a failure in structures (Kovler and Chernov, 2009). Fig 1.1 & Fig 1.2 are the example of damage caused by physical factors

Chemical Factors: This includes acids, leaching of salts, organic substances, etc. There are three primary categories of chemical causes of concrete damage, which are,

- Cation-exchange interactions between aggressive fluids and the cement paste cause an alkali-aggregate reaction is that results in the creation of expanding products. The concrete expansion might have a prestressing effect before fracturing and causing structural damage.

  Sulfate attack due to soft water cause hydrolysis of cement paste. Sulfates in solution in contact with concrete can produce chemical changes in the cement, resulting in severe microstructural impacts and cement binderdeg radiation

Objectives

Based on the research gaps obtained from the literature review, following objectives are framed.

- To find the seismic behavior of multi–storey structures by introducing the damage in beams and columns with various damage severities
- To compare various parameters like time period, axial load, displacement, for different damage conditions.
- Identifying the critical damage scenario based on the location and severity

2 ,METHODOLGY

- The study aims to analyze the dynamic behavior of a 3D RC frame structure
- Deliberate damage is introduced by altering material properties in beams and columns
- Damage occurs at specific storeys or levels within the structure.
- The research systematically increases damage severity to assess its impact.
- The dynamic analysis of the frame structure is conducted with full-length damage considered in both beams and columns

Material Properties

Youngs Modulus of concrete	Ec=22360.67
Poisson's ratio of concrete	(µ)= = 0.2
Density of Concrete	25 KN/m3
Rebar	Fe=500
Design code	IS456:2000 , IS 1893:2016

Geometrical properties of 3D frame structure

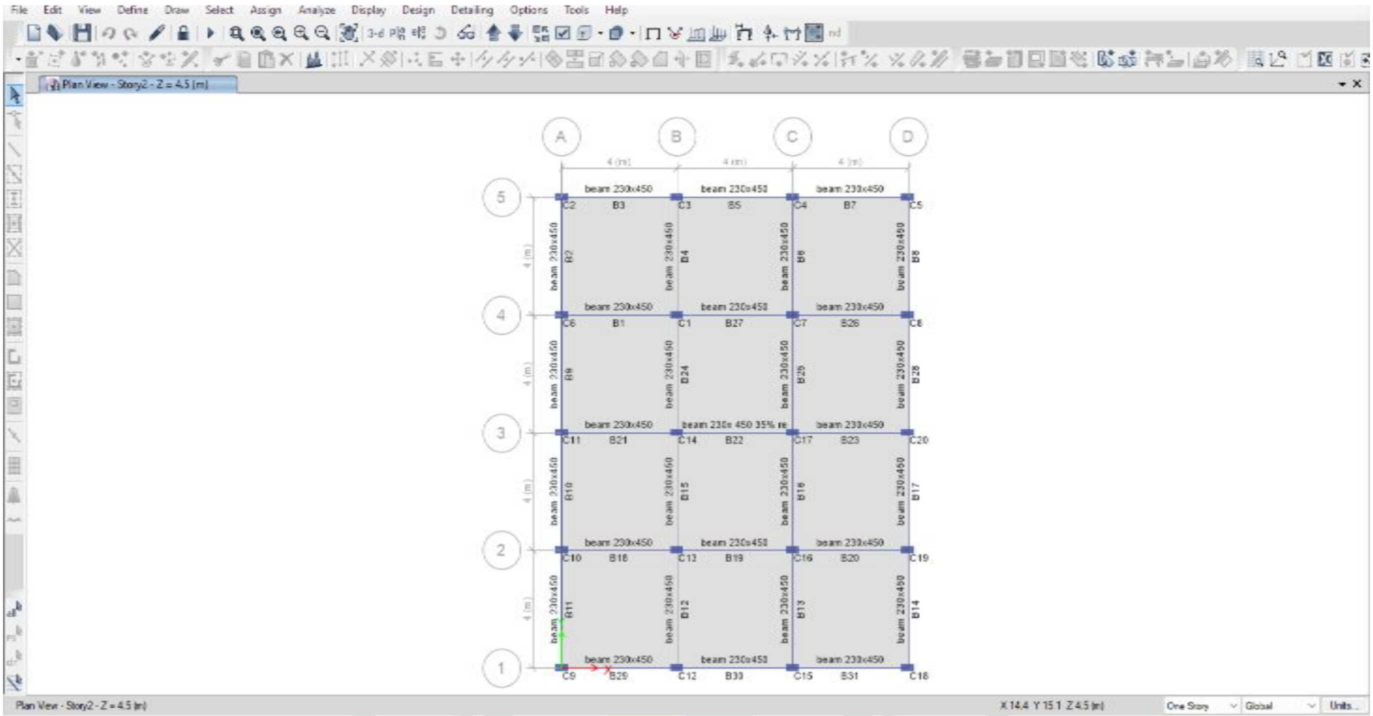
5 STORY	8 STORY
Height of each storey = 3 m	Height of each storey = 3 m
Dimension of a beam = 230 × 450 mm	Dimension of a beam = 230 × 450 mm
Column dimension = 230 × 450mm	Column dimension = 300× 450 mm
Thickness of slab = 150 mm	Thickness of slab = 150 mm

Load considered for analysis

Loads (Units)	Details	Relevant Code
Dead Load (KN/m)	Automated	
Wall Load (KN/m)	13.8	
Parapet Wall Load (KN/m)	3	
Floor Finish (KN/m^2)	1.5	IS:875-1987[Part 1]
Live Load (KN/m^2)	3	IS:875 1987[Part 1]

Seismic parameter considered for analysis (IS:1893(Part-1): 2016)

Seismic Parameters	Details	Magnitude
Seismic zone (Z)	V	0.36
Soil type	Ⅲ	
Importance Factor, I	Important service and Community buildings or structures	1.5
Response Reduction Factor, R	RC building with Special Moment Resistance Frame	5
Natural Time Period, Ta	RC MRF building without masonry infill	0.389 sec



3 .RESULTS AND DISCUSSIONS

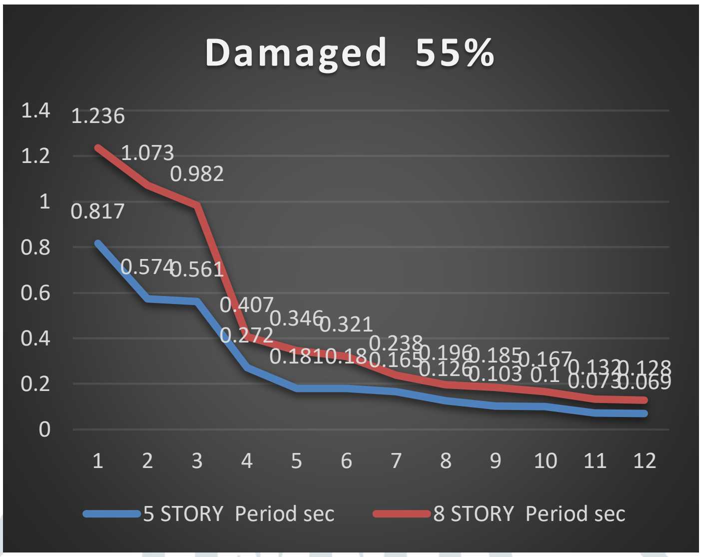
Time period

The mass and stiffness of the building regulate the building's fundamental property of time period. Time period and amount of dampening in each mode of vibration determine the safety of the structure. The time period is important factor to understanding how a construction behaves dynamically. The natural frequency of structure measures, how many times the structure sways for one second after being excited before returning to its previous position. It also depends on the mass and stiffness of the structure

WHEN COLUMN AND BEAM ARE DAMAGED IN 5 STORY AND 8 STORY MODELS CASE (2)

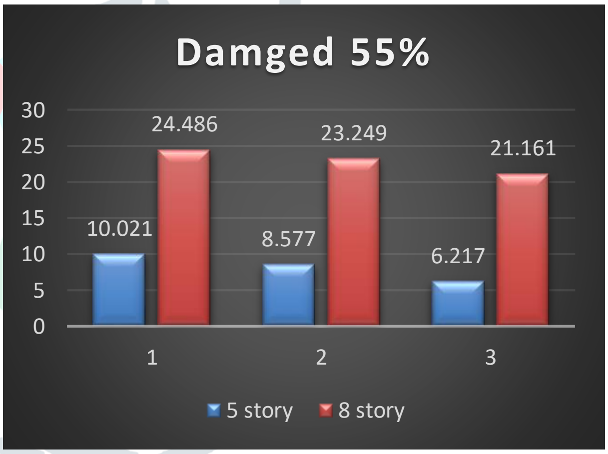
Damaged 55%			
		5 STORY	8 STORY
Case	**Mode**	**Period**	**Period**
		sec	sec
Modal	1	0.817	1.236
Modal	2	0.574	1.073
Modal	3	0.561	0.982
Modal	4	0.272	0.407
Modal	5	0.181	0.346
Modal	6	0.18	0.321
Modal	7	0.165	0.238

Modal	8	0.126	0.196
Modal	9	0.103	0.185
Modal	10	0.1	0.167
Modal	11	0.073	0.132
Modal	12	0.069	0.128



Lateral displacement of damaged and undamaged frame column And beam damage (CASE 2)

	Damaged 55%	
	5 story	8 story
1	10.021	24.486
2	8.577	23.249
3	6.217	21.161

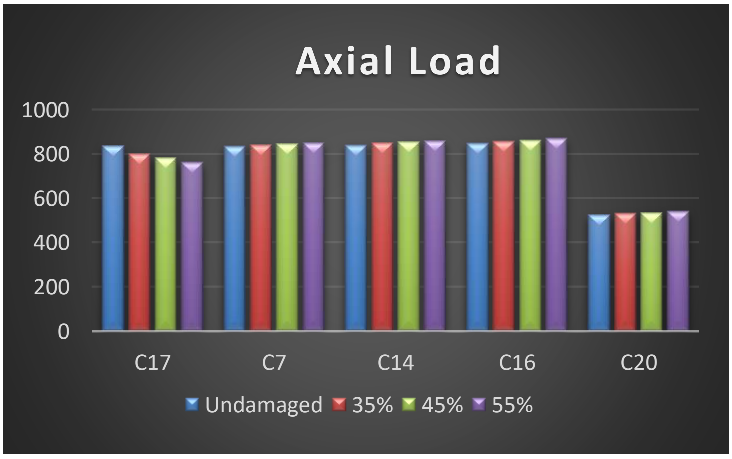


Axial force

Axial force of columns in storey 5 Damage and undamaged (CASE 1)

Only column Damage and undamaged				
COLUMN	**NORMAL**	**35%**	**45%**	**55%**
C17	834.94	800.21	783.35	760.3
C7	833.65	841.13	844.96	850.32
C14	839.63	849.61	854.35	860.76
C16	848.23	858.1	862.7	868.87
C20	524	531.72	535.55	540.86

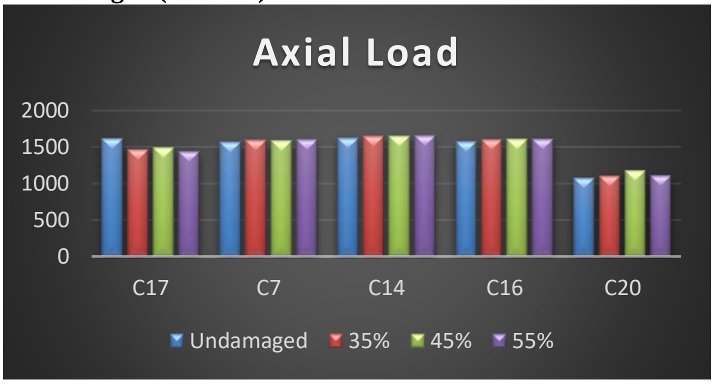
Only column damaged and Undamaged



column Beam damage and undamaged				
SCOLUMN	**NORMAL**	**35%**	**45%**	**55%**
C17	1616.72	1463.54	1491.02	1438.39
C7	1561.61	1591.2	1583.04	1597.88
C14	1618.75	1651.78	1648.22	1657.6
C16	1569.24	1602.24	1603.58	1607.73
C20	1072.85	1104.17	1179.03	1110.18

only column Beam damaged and Undamaged

Axial force of columns in storey 8 Damage and undamaged (CASE 2)



4 .CONCLUSIONS

1. The time period of the structure increases, the damage severity increases. Decrease in time period causes the 5 storey building to behave more rigidly. (From Table No10.)
2. Maximum displacement is observed in case 2 when damage intensity is 55%. The height increases lateral displacement in influenced by the height of the structure.
3. The increment in the damage severity will reduce the load carrying capacity of the column, which means the axial load at the column reduces.
4. The same can be observed, when the damage intensity is 55% the axial load on the columns adjacent to the damaged columns is slightly increased when compared to undamaged structure.
5. Based on the analytical results damage intensity was severe in case 2 when the damage intensity is 55%.

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