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Research Article

Increasing Stability of Multistoried Building using Different Grades of Concrete in Column Member Sets at Different Locations

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Abstract

Concrete is the mainly unquestionable and essential material being used in construction with developing infrastructure throughout the world. The strength of components of a structure creates stiffness regularity for the whole linkage connectivity. As the current study carried out a comparative and understandable behavior of the multistoried building column component with regular and irregular grade of concrete. A software analytical approach is used for the analysis of total five similar building models with same and different grades. Different cases show its different behavior and define its own importance of grade change. At last conclusions have drawn for the efficient and final case that shows optimal location of grade change in concrete columns in a symmetric structure. Grade location case T shows least parametric values after comparison with other grade location cases.

Keywords: *Axial forces, Beam, Column, Concrete grade, Shear forces, Stability, Displacement, Tall structure, Torsion.*

1. Introduction

As it has been predefined that column is the vertical stiffness component and it transfers the load from level to level of the floor and ultimately transfers the same to the ground. As this component generally made up of R.C.C., steel, timber, composite materials, etc. as per the requirement of the uniformity. In R.C.C. structure, concrete is basically a key component and an artificial stone, well molded, transfer load as per its designed capacity.

R.C.C. column is the spinal cord when discussing specific on multistoried building. Changing grade of concrete has its own importance. Since if same grade of concrete has used in the structure, its behavior over the entire remains the same. But what if a multistoried building when having different grades in column member shows different behavior in terms of various parameters applied on it.

2. Objectives of the Current Study

The study consist of change in grading location with total five model cases of different grades of columns and a comparative analysis will be analyzed on different parameters include shear forces, moments, displacements, base shear etc. in longitudinal and transverse direction. These 5 locations of grade change of column in the multistoried building rests on medium soil under the existence of seismic forces as per Indian standard earthquake Zone III. The following objectives have been used in this study:-

1) To find out the nodal displacement effect in both X and Z direction in terms of the grade change of the concrete member in the structure.
2) To show the base shear effects in both X and Z direction in terms of the grade change of the concrete member in the structure.
3) To discuss the axial force in column in terms of the grade change of the concrete member in the structure.
4) To analyze the absolute shear forces and moment in column and beam member in terms of the grade change of the concrete member in the structure.
5) To evaluate and compare torsional moment in beam
6) To prove the overall behavior of structure in terms of grade change of column components in the multistoried building.

3. Procedure and 3d Modeling of the Structure

As per criteria for earthquake resistance design of structures, a commercial building (G+15) with plinth area 576 sq. m. has taken for analysis. A total of five different cases have been chosen for parametric analysis, its description shown below. Various

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dimensions of structure are shown in Table 1, seismic parameters taken have shown in Table 2 respectively.

Dead loads, Live loads, Response spectrum loads are applied on the structure with various load combinations. M25 grade and M 35 grade of concrete used with Fe 415 grade of steel is used. After then five building cases described and each of them abbreviated as P, Q, R, S and T. Figure 1 shows typical floor plan as per selected grid system. After then, comparative results of various parameters shown in tabular form with graph is provided to compare each parameter figuratively.

Table 1: Dimensions of different components of building

Parameters	Values
Building Length	6m @ 4 bays = 24m
Building Width	4m @ 6 bays = 24m
Height of each floor	Ground = 4m, Each floor height = 3m
Depth of footing	3m
Beam dimensions	0.50 m x 0.25 m
Column dimensions	0.40 m x 0.25 m
Slab thickness	0.130 m
Shear wall thickness	0.180 m

Table 2: Seismic parameters on the structure

Parameters	Values
Importance factor I	1.2
Fundamental natural period (Ta) in X and Z direction	0.9553 seconds
Response reduction factor R	4
Zone factor	0.16
Structure Type	RC frame Structure
Zone	III
Soil type	Medium soil

Different building model cases selected for analysis using ETABS software

1) **Model P** = All M25 Grade components.
2) **Model Q** = All M25 Grade components except (Column A1, A5, G1, G5) (M35 grade).
3) **Model R** = All M25 Grade components except (Column D1, A3, D5, G3) (M35 grade).
4) **Model S** = All M25 Grade components except (Column B2, B4, F2, F4) (M35 grade).
5) **Model T** = All M25 Grade components except (Column C2, C4, E2, E4) (M35 grade).

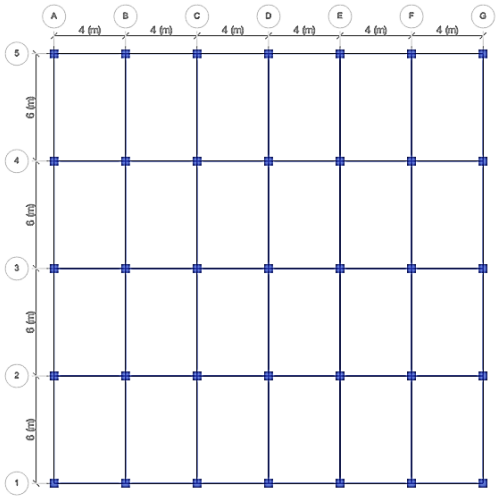


Fig 1: Typical floor plan

4. Results Analysis

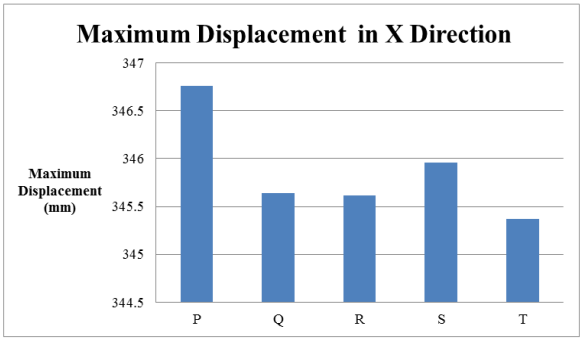
For the stability of the structure by changing the grade of concrete in columns at different pairs, parameters such as the nodal displacement, base shear, column axial forces, column shear and moment values, beam shear and moment values and last but not the least beam torsion values.

The above parameters obtained by the application of loads and their combinations on various cases of the multistory building as per Indian Standard 1893: 2016 code of practice.

Tabular result of each parameters and its optimal case has discussed with its graphical form below:-

Table 3: Maximum nodal displacement in X direction for all five grade pair location cases in Zone III

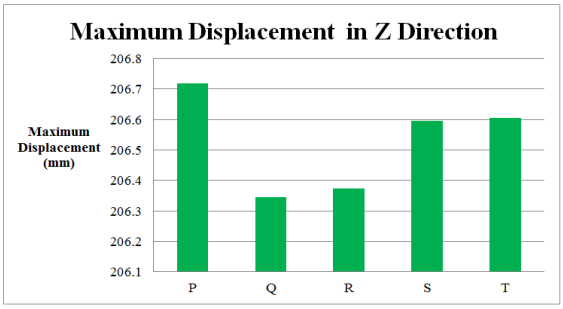
Grade Location Case	Maximum Displacement (mm)
	In X Direction
P	346.759
Q	345.636
R	345.615
S	345.961
T	345.366



Graph 1: Maximum nodal displacement in X direction for all five grade pair location cases in Zone III

Table 4: Maximum nodal displacement in Z direction for all five grade pair location cases in Zone III

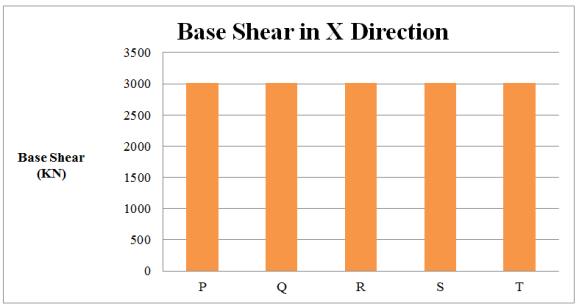
Grade Location Case	Maximum Displacement (mm) In Z Direction
P	206.719
Q	206.345
R	206.375
S	206.597
T	206.606



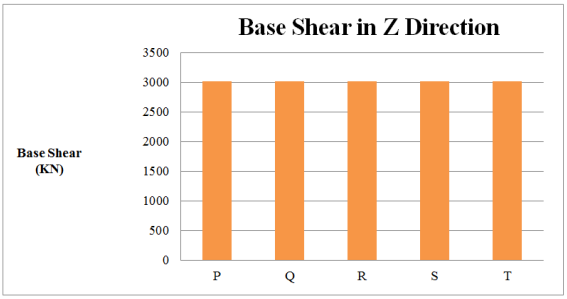
Graph 2: Maximum nodal displacement in Z direction for all five grade pair location cases in Zone III

Table 5: Base Shear in X and Z directions for all five grade pair location cases in Zone III

Grade Location Case	Base Shear (KN)	
	X direction	Z direction
P	3016.6284	3016.6284
Q	3016.6284	3016.6284
R	3016.6284	3016.6284
S	3016.6284	3016.6284
T	3016.6284	3016.6284



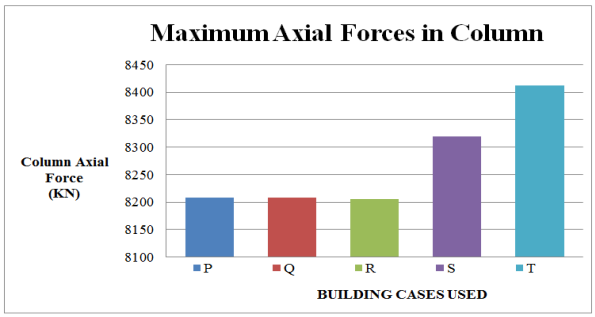
Graph 3: Base Shear in X and Z directions for all five grade pair location cases in Zone III



Graph 4: Base Shear in X and Z directions for all five grade pair location cases in Zone III

Table 6: Maximum Axial Forces for all five grade pair location cases in Zone III

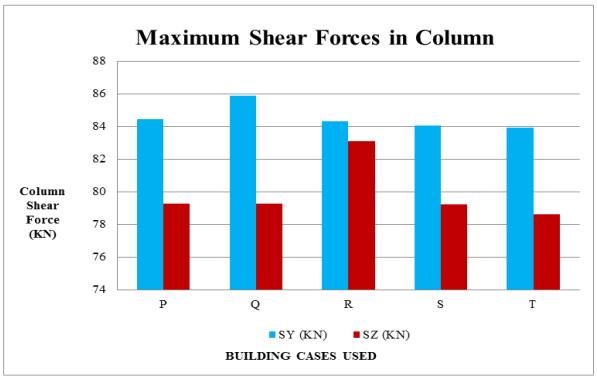
Grade Location Case	Column Axial Force (KN)
P	8208.2828
Q	8208.125
R	8205.5151
S	8319.4758
T	8411.6627



Graph 5: Maximum Axial Forces for all five grade pair location cases in Zone III

Table 7: Maximum Shear Forces in Columns for all five grade pair location cases in Zone III

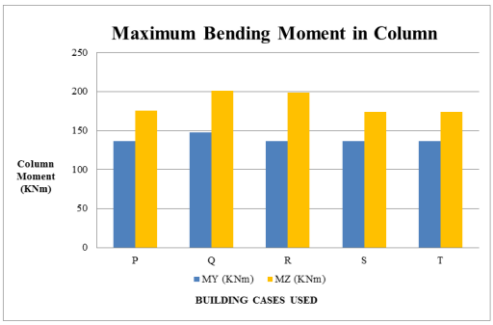
Grade Location Case	Column Shear Force (KN)	
	Shear along Y	Shear along Z
P	84.4264	79.2826
Q	85.8562	79.28
R	84.3113	83.0709
S	84.0684	79.236
T	83.9356	78.6167



Graph 6: Maximum Shear Forces in Columns for all five grade pair location cases in Zone III

Table 8: Maximum Bending Moment in Columns for all five grade pair location cases in Zone III

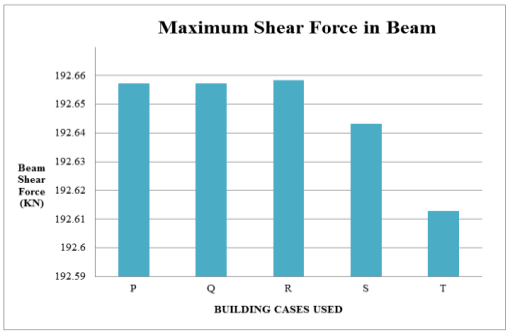
Grade Location Case	Column Bending Moment (KNm)	
	Moment along Y	Moment along Z
P	136.4719	175.7394
Q	147.8818	201.0845
R	136.2552	198.6936
S	136.2701	174.7822
T	136.2444	174.4252



Graph 7: Maximum Moment in Columns for all five grade pair location cases in Zone III

Table 9: Maximum Shear Forces in Beams for all five grade pair location cases in Zone III

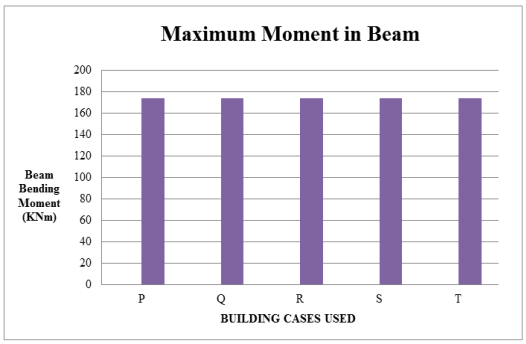
Grade Location Case	Beam Shear Force (KN)
P	192.6572
Q	192.6572
R	192.6584
S	192.6433
T	192.6129



Graph 8: Maximum Shear Forces in Beams for all five grade pair location cases in Zone III

Table 10: Maximum Bending Moment in beams for all five grade pair location cases in Zone III

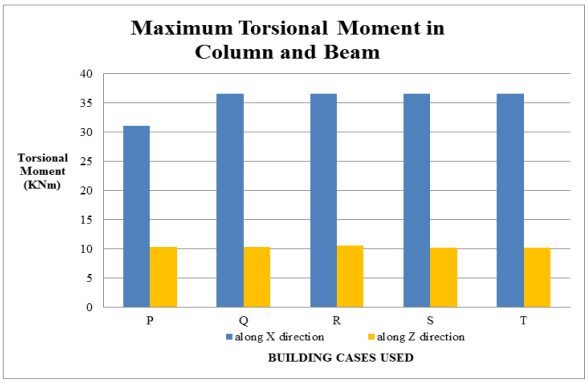
Grade Location Case	Beam Moment (KN)
P	174.0555
Q	174.0408
R	173.9604
S	173.9165
T	173.4012



Graph 9: Maximum Bending Moment in beams parallel to X direction for all five grade pair location cases in Zone III

Table 11: Maximum Torsional Moment in beams along X and Z directions for all five grade pair location cases in Zone III

Grade Location Case	Column Torsional Moment (KNm)	Beam Torsional Moment (KNm)
P	31.0856	10.3554
Q	36.6379	10.318
R	36.6368	10.5933
S	36.6577	10.2663
T	36.5832	10.2931



Graph 10: Maximum Torsional Moment in beams along X and Z directions for all five grade pair location cases in Zone III

Conclusions

Conclusions evolved by analyzing the result data of various parameters for all five grade pair location cases are as follows:-

1) Nodal displacement in X direction and Z direction shows least value when grade location case T will be used.
2) The base shear result will not show a particular change, since none of the member is increasing or decreasing from framed multistoried building structure.
3) Axial force parameter in column shows least value in R and more aggressive when grade location case T will be used.
4) Maximum shear force in column (both in Sy and in Sz) shows least value when grade location case T will be used.
5) Both shear force and moment in beam also is in the favor when grade location case T will be used.
6) Again torsion moment both in beam and in column shows least value when grade location case T will be used.

Under the effect of earthquake forces, the column grade pair case shows a drastic result on comparing a singular grade in entire building. After analyzing, Grade

location case T shows least parametric values after comparison with other grade location cases.

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