An Analysis of G+7 Irregular Building Using Non-Linear Static and Dynamic Analysis

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ABSTRACT

Urbanization and industrialization have paved the way for the rise of towering multi-story buildings in uneven regions all over a developing country such as India because urbanization and industrialization have paved the way for the growth of towering multi-story structures. Due to their irregular and asymmetrical vertical and even plane architecture, structures formed in bumpy zones differ from those developed on level ground. These constructions are also far more susceptible to earthquake forces in uneven terrain. Thinking about how buildings behave on slanting terrain is the main objective of the current effort. Unlike buildings built on flat land, structures built on sloped terrain require special architectural considerations. The structures on slopes differ from those in fields. When affected by seismic earthquakes, they are torsional-linked, extremely unexpected, and asymmetrical in even and vertical planes. As a result, they are unable to separate injuries. This paper has made an effort to analyze how sporadic multi-story construction on an inclined ground of 60 degrees behaves while considering various earthquake zones, such as zone IV. The models are readied using STAAD Pro and REVIT. STAAD Pro offers advanced and adaptable analysis for specialized applications including gravity loads and earthquake analysis.

Keywords— skyscraper multi-story structures; unsymmetrical structure; STAAD Pro; REVIT

I. INTRODUCTION

The most awful and unpredictable act of nature is a seismic quake. When a structure is exposed to seismic pressures, it does not always endanger human life since the design damage causes the building to collapse, endangering the lives of its occupants and property. The continuous quakes' widespread devastation of both low- and high-rise buildings forces an evaluation, particularly in a developing nation like India. Design subjected to seismic/quake forces are always susceptible to damage, and if it happens on a skewed structure—such as an incline that tends to the ground—the chances of harm increase significantly because of extended sidelong powers on short segments on the extreme side, which encourages the use of plastic turns. Designs on slopes differ from those on fields because they are asymmetrical in both an upward and a level plane. India's northern and northeastern regions feature large slanting areas classified as seismic zones IV and V. The earthquakes in Nepal (2015), Doda (2013), and Sikkim (2011) all caused enormous damage. Due to the rapid urbanization, addition in financial turn of events, and consequent growth in population thickness, there is interest in the advancement of multi-story RC enclosed structures in this area. The progress of the buildings on the sloping ground is required due to the need for a plain region. The current work uses STAD Pro and REVIT to demonstrate a G+7-storeyed maintained design with a tendency of 30° to the ground subject to sinusoidal ground development. When a design is exposed to seismic pressures, it does not immediately affect living things. However, the building damage causes the design to fail, affecting the people living there and their property. The recurrent earthquakes that cause massive harm to low and towering structures call for an examination, particularly in a developing nation like India. Design subject to seismic/quake forces is always at risk of injury, and if it happens on a skewed structure, such as an incline that is inclined to the ground, the chances of injury increase noticeably because of prolonged equal forces on small portions on the intense side, which encourages the development of plastic turns. STAAD Pro features a cutting-edge user interface, visualization tools, and strong analysis and design engines with advanced finite element and dynamic analysis capabilities. Designing low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles, and other structures out of steel, concrete, wood, aluminium, and cold-formed steel is possible using STAAD Pro, the professional's choice. This covers the development, evaluation, design, visualization, and outcome validation of models.

II. LITERATURE REVIEW

B. Gireesh [1] used the Staad Pro program to study the structural and seismic analyses of the G+7 construction. He used IS 1893 (Part 1) - 2007 as an Indian standard code for design base shear. According to IS 1893:2002, multiple analytical criteria depending on the building's height, zone of location, and importance were stated for the earthquake-resistant criterion. Various loads were applied after the project was launched, including dead loads, live loads, wind loads, snow loads, and earthquake loads, for which the analysis will be performed. The structure was created for the Hyderabad region under Zone II. V. Varalakshmi [2] a multi-story G+5 skyscraper in Kukatpally, Hyderabad, India, and its design and analysis. The design and analysis of columns, beams, footings, and slabs were performed using the renowned civil engineering tool STAAD Pro. The soil's capacity for safe bearing was evaluated. P. Jayachandran [3] G+4 building design and analysis in Salem, Tamil Nadu, India. The research analyzes and designs footings, columns, beams, and slabs using the STAAD Pro and RCC Design Suit software. L.G. Karulkar [4] G+5 building design and analysis in an earthquake zone employing composite structures. Three-dimensional modeling and analysis of structures are done using the SAP 2000 application. When studying composite and RCC structures, equivalent static methodologies and response spectrum analysis approaches are used. The composite structure is shown to be more economical after comparing the results. Using the most cost-effective column technique, M. Mallikarjun (2016 [5] researched the study and design of a multi-story residential structure with ung-2+G+10. It was discovered that because the research was conducted using the most cost-effective column approach, this was done by lowering the size of columns on top floors because the load was more significant at the bottom level. The dead and live loads were applied to various structural components, including slabs and beams. Columns were oriented in a greater span in a longer direction to save money by reducing the amount of bending and steel area needed to support them. According to Mohit Sharma (2015) [6], the building has a G+30-story conventional reinforced concrete frame. Multi-story buildings underwent dynamic analysis. A selected building's overall height, including the depth of the foundation, is 114 m. These structures have a plan area of 25 m by 45 m, a height of 3.6 m per story, and a foundation depth of 2.4 m. STAAD-Pro software was used for static and dynamic analysis on a computer using the design parameters specified in IS:1893-2002 Part-1 for zones 2 and 3. The Axial Force values were determined to be comparable to those from static and dynamic analysis.

III. OBJECTIVE OF PRESENT STUDY

The purpose of this research is to study P-Delta and Pushover analysis which are very important in the designing and Analysis of multi-storeyed buildings.

1) The building should survive significant earthquakes that could be anticipated during its service life with damage that is within acceptable bounds.
2) Study of P-Delta effect on building.
3) Study of Push over analysis of building.
4) Check for stability of building in a hilly slope.

IV. METHODOLOGY

Proposed Tool and Methodology

STAAD Pro will analyse and design a multi-story residential structure from various angles in this project. A thorough structural analysis is necessary for structural designing so that the structure may be designed. However, manual calculations are not always feasible, which is why the necessity for programming tools was discovered.

For this purpose, several tools were developed, the most popular of which is STAAD Pro, which enables structural and seismic analysis prior to construction. STAAD Pro may be used to compute loads and their combinations, analyse structures, and design structures based on the analysis for high-rise buildings.

A. **P-Delta Effect on Building**

The structure may undergo greater lateral displacements as a result of gravity loading when a building is subjected to seismic lateral stress that causes it to deflect. The second-order influence of vertical loads operating onto a laterally displaced structure is known as the P- Δ effect, where P is the total vertical load and Δ is the lateral displacement with respect to the ground. The P- Δ effect illustrates how the mass of a structure moves under the influence of a weight P through a displacement Δ, creating a moment at the base of the structure.

B. **Pushover analysis on Building**

Pushover analysis is a static method that uses a streamlined nonlinear approach to calculate seismic structural deformations. After an earthquake, structures reconstruct on their own. As individual ones lose way or fail, the dynamic forces acting on the structure are transmitted to other components.

V. P-DELTA ANALYSIS OF G+7 BUILDING BY USING STAAD PRO

1. Building Parameters

Table 1: Structural Data and Parameters Adopted for Model

Column	400mm x 500mm
Beam	500mm x 750mm
Material used	Reinforce cement concrete
Concrete Frame	SMRF
Main Wall	230mm
Reinforcement used	HYSD
Slab thickness	150mm
Unit weight of concrete	25KN/CUM
Concrete grade	M40
Steel Grade	Fe500
Floor to floor height	3.5m
Number of floors	G+7
No. of beam + column	220 + 142
Length of plan in x-direction	20m
Length of plan in z-direction	18m

2. Plan of Residential Building on AUTO CAD and REVIT

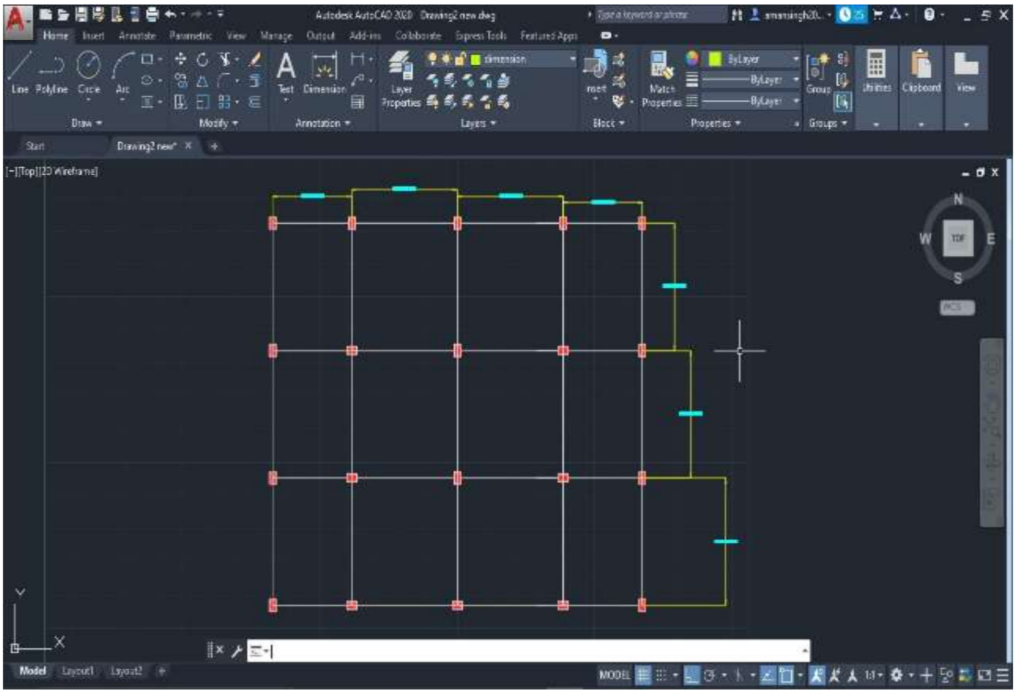

Fig. 1: Column layout of Structure

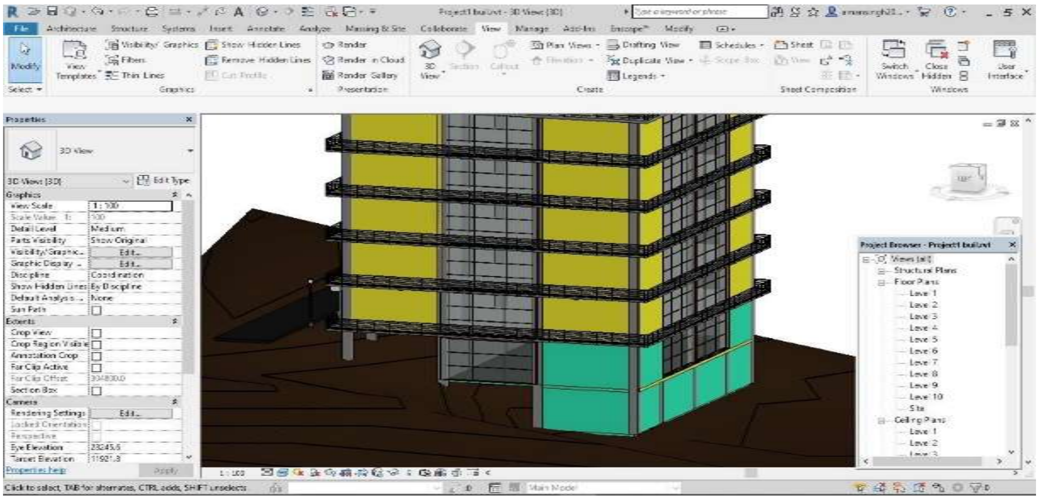

Fig. 2: Isometric view of the irregular building

3. Loads acting and their calculation
   a) Dead Load

Table 2: Dead Load Parameter

Dead load of different components	*Load*
Slab	3.75KN/m^2
Floor finish	1.575KN/m^2
Celling Plaster	0.168 KN/m^2
Wall	13.248 KN/m
Both side plaster wall	1.96 KN/m
Parapet wall	2.286 KN/m

b) Live load –

For floor UDL = 3KN/m^2

For roof UDL = 2.8KN/m^2

Point load = 1.8 KN

c) Wind load –

$P_z = 0.6V_z^2$

$V_z = V_b \times k_1 \times k_2 \times k_3 \times k_4$

V_b = 47m/s (Darjeeling)

K_1 = Risk coefficient = 1

K_2 = terrain coefficient = 0.93

K_3 = topo coefficient = 1

K_4 =1

V_z = 43.71 m/s

P_z = 1.14633KN/m^2

Table 3: Wind loads at different height

height (m)	K_1	K_2	K_3	K_4	V_b	P_z (KN/m^2)
10	1	0.91	1	1	47	1.097
15	1	0.97	1	1	47	1.247
20	1	1.01	1	1	47	1.352
30	1	1.06	1	1	47	1.489
50	1	1.12	1	1	47	1.662
100	1	1.20	1	1	47	1.908
150	1	1.24	1	1	47	2.037

4. The P-Delta Analysis is carried out for the proposed unsymmetrical building resting on a hill slope.

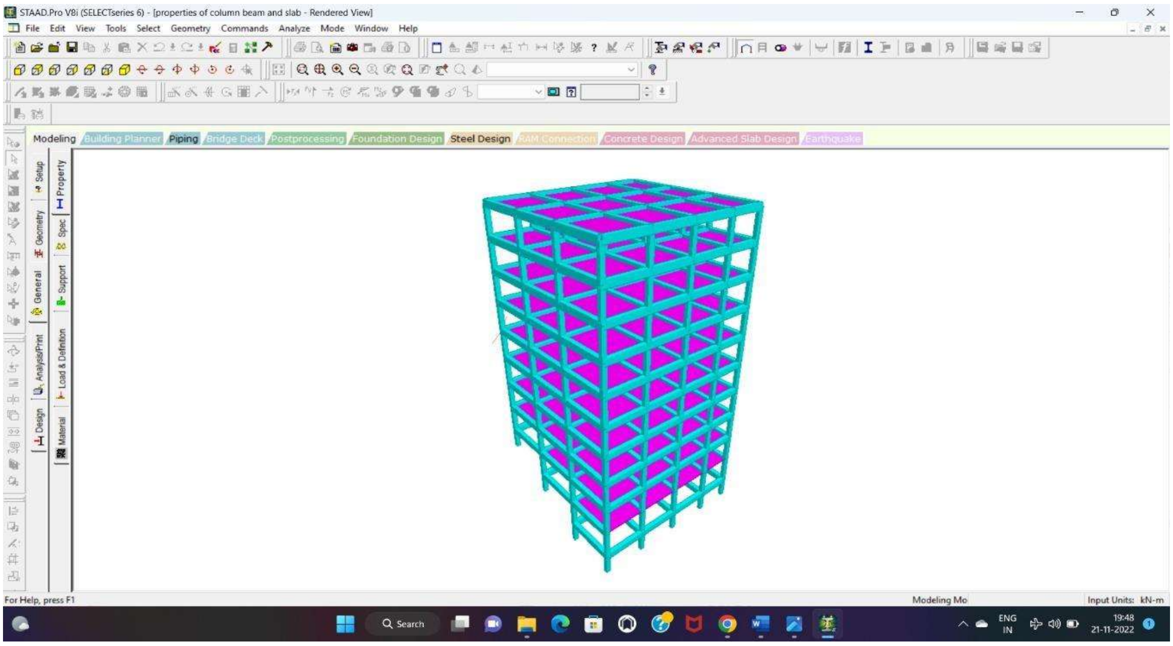

Fig. 3: 3-D rendering view

5. Results obtained from P-Delta Analysis

Table 4: Deflection obtained on Column

Ground floor	0.756mm
1^{st} floor	1.489mm
2^{nd} floor	2.131mm
3^{rd} floor	2.709mm
4^{th} floor	3.218mm

5^{th} floor	3.661mm
6^{th} floor	4.040mm
7^{th} floor	4.360mm
8^{th} floor	4.627mm

Table 5: Deflection obtained on Beams

Beam 1	2
Beam 2	2
Beam 3	1

VI. PUSHOVER ANALYSIS OF G+7 BUILDING BY USING STAAD PRO

Using the static-nonlinear analytical technique known as "pushover," a structure is subjected to gravity loading and a monotonic displacement-controlled lateral load pattern. The load is continuously increased through both elastic and inelastic behavior until an ultimate state is reached. Indicating the range of base shear brought on by earthquake loading, the configuration of the lateral load may be proportionate to the distribution of mass along the building height, mode forms, or another practical technique.

A structure with constant vertical loads and growing lateral loads is the subject of a static non-linear pushover analysis. The forces brought on by earthquakes are represented by equivalent static lateral loads. This method displays any early failure or weakness by plotting a structure's total base shear vs. top displacement. It is able to determine the collapse load and ductility capability because the study was conducted until failure. On a building frame, plastic rotation is observed, and analytically calculated lateral inelastic forces versus displacement. Finding structural faults is made possible by this type of research. It is possible to decide to retrofit after conducting such studies. There are two steps in the seismic design process. Developing an effective structural system is the first and frequently most important phase. It must be constructed carefully taking into account all significant seismic performance requirements, ranging from serviceability challenges. The seismic engineering process is currently complete. The general guidelines for the strength and stiffness objectives should be adequate to design and roughly size an effective structural system. These recommendations are predicated on a fundamental comprehension of ground motion and the features of elastic and inelastic dynamic response. Only when a structural framework has been created is it possible to build complex mathematical/physical models. It is necessary to use these models when evaluating the seismic performance of an existing system and when modifying component behavior parameters (strength, stiffness, and deformation capacity) in order to improve performance.

In the Pushover analysis, the strength and deformation demands of design earthquakes are identified using static inelastic analysis and compared to the available capacities at the desired performance levels. Through static inelastic analysis, structural systems are assessed to determine the anticipated performance levels. The assessment of key performance parameters, including global drift, inter-story drift, inelastic element deformations (either absolute or normalized concerning a yield value), deformations between elements, and element connection forces (for elements and connections that cannot sustain inelastic deformations), form the foundation of the evaluation. The inelastic static pushover analysis can be viewed as a tool for predicting seismic force and deformation needs after earthquakes based on analysing crucial performance. The pushover is expected to show a number of reaction qualities that cannot be discovered through an elastic static or dynamic analysis.

These are some instances of such response characteristics: Axial force requirements for columns, force requirements for brace connections, and moment requirements for possibly brittle parts are examples of realistic force requirements.

➢ Beam-to-column connections, shear force requirements for deep reinforced concrete spandrel beams, and shear force requirements for unreinforced masonry wall piers, among others.

➢ Estimates of the deformations ask for components that must take an elastic form to release the energy applied to the structure.

➢ How the behaviour of the structural system is affected by the weakening of specific parts.

➢It determines the crucial areas that must be the centre of attention via detailing and where significant deformation demands are anticipated.

➢The dynamic characteristics of the elastic range will change depending on how strong the discontinuities are in the plan elevation.

➢ Understory drift can be estimated by considering strength discontinuities or stiffness discontinuities in order to reduce damages and assess P-Delta impacts.

Check the load path's accuracy and completeness while considering all the structural system's components, linkages, stiff non-structural elements, and foundation system.

Results of Pushover Analysis

Table 6: Displacement on floors (mm)

	U_x	U_y	U_z
Ground Floor	-0.789	-32.495	-0.016
1st Floor	-1.451	-58.913	-0.155
2nd Floor	-2.032	-81.277	-0.353
3rd Floor	-2.569	-100.415	-0.593
4th Floor	-2.946	-99.323	2.020
5th Floor	-3.476	-114.945	1.283
6th Floor	-3.856	-140.092	-1.315
7th Floor	-4.178	-147.587	-1.476
8th Floor	-4.686	-152.250	-1.559

VII. RESULTS AND CONCLUSION

The P-Delta and Pushover Analysis has been carried out for a G+7 multistorey building and the following results have been found out using STAAD. Pro software. It has been observed that the maximum and minimum deflection in beam is 2.713mm and 1.728mm respectively. For the columns, the maximum and minimum deflection is 4.627mm and 0.756mm respectively. The maximum and minimum displacement is observed in pushover analysis with 152.250mm and 0.789mm the respective values.

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APPENDIX

Proprietary Program of Bentley Systems, Inc.

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1. STAAD SPACE
INPUT FILE: C:\SProV8i SS6\STAAD\Plugins\P DELTA OF DL+LL+WL.STD
2. START JOB INFORMATION
3. ENGINEER DATE 20-NOV-22
4. END JOB INFORMATION
5. INPUT WIDTH 79
6. UNIT METER KN
7. JOINT COORDINATES
8. 1 0 0 0; 2 0 0 6; 3 0 0 12; 4 0 0 18; 5 5 0 0; 6 5 0 6; 7 5 0 12; 8 5 0 18
9. 9 10 0 0; 10 10 0 6; 11 10 0 12; 12 10 0 18; 13 15 0 0; 14 15 0 6; 15 15 0 12
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109. 382 31 35; 383 35 39; 384 24 28; 385 28 32; 386 32 36; 387 36 40; 388 41 45
110. 389 45 49; 390 49 53; 391 57 53; 392 42 46; 393 46 50; 394 50 54; 395 54 58
111. 396 43 47; 397 51 47; 398 51 55; 399 55 59; 400 44 48; 401 48 52; 402 52 56
112. 403 56 60; 404 61 65; 405 65 69; 406 69 73; 407 77 73; 408 62 66; 409 66 70
113. 410 70 74; 411 74 78; 412 63 67; 413 71 67; 414 71 75; 415 75 79; 416 64 68
114. 417 68 72; 418 72 76; 419 76 80; 420 81 85; 421 85 89; 422 89 93; 423 97 93
115. 424 82 86; 425 86 90; 426 90 94; 427 94 98; 428 83 87; 429 91 87; 430 91 95
116. 431 95 99; 432 84 88; 433 88 92; 434 92 96; 435 96 100; 436 101 105
117. 437 105 109; 438 109 113; 439 117 113; 440 102 106; 441 106 110; 442 110 114
118. 443 114 118; 444 103 107; 445 111 107; 446 111 115; 447 115 119; 448 104 108
119. 449 108 112; 450 112 116; 451 116 120; 452 121 125; 453 125 129; 454 129 133
120. 455 137 133; 456 122 126; 457 126 130; 458 130 134; 459 134 138; 460 123 127
121. 461 131 127; 462 131 135; 463 135 139; 464 124 128; 465 128 132; 466 132 136
122. 467 136 140; 468 141 145; 469 145 149; 470 149 153; 471 157 153; 472 142 146
123. 473 146 150; 474 150 154; 475 154 158; 476 143 147; 477 151 147; 478 151 155
124. 479 155 159; 480 144 148; 481 148 152; 482 152 156; 483 156 160; 484 161 165
125. 485 165 169; 486 169 173; 487 177 173; 488 162 166; 489 166 170; 490 170 174
126. 491 174 178; 492 163 167; 493 171 167; 494 171 175; 495 175 179; 496 164 168
127. 497 168 172; 498 172 176; 499 176 180; 500 197 199; 501 199 201; 502 201 203
128. 503 203 205; 504 196 198; 505 198 200; 506 200 202; 507 202 204; 508 181 184
129. 509 184 187; 510 187 190; 511 190 193; 512 182 185; 513 188 185; 514 188 191
130. 515 191 194; 624 183 186; 625 186 189; 626 189 192; 627 192 195
131. ELEMENT INCIDENCES SHELL
132. 516 161 165 166 162; 517 165 169 170 166; 518 169 173 174 170
133. 519 173 177 178 174; 520 141 145 146 142; 521 145 149 150 146
134. 522 149 153 154 150; 523 153 157 158 154; 524 121 125 126 122
135. 525 125 129 130 126; 526 129 133 134 130; 527 133 137 138 134
136. 528 101 105 106 102; 529 105 109 110 106; 530 109 113 114 110
137. 531 113 117 118 114; 532 81 85 86 82; 533 85 89 90 86; 534 89 93 94 90
138. 535 93 97 98 94; 536 61 65 66 62; 537 65 69 70 66; 538 69 73 74 70
139. 539 73 77 78 74; 540 41 45 46 42; 541 45 49 50 46; 542 49 53 54 50
140. 543 53 57 58 54; 544 21 25 26 22; 545 25 29 30 26; 546 29 33 34 30
141. 547 33 37 38 34; 548 2 6 7 3; 549 6 10 11 7; 550 10 14 15 11; 551 14 18 19 15
142. 552 22 26 27 23; 553 26 30 31 27; 554 30 34 35 31; 555 34 38 39 35
143. 556 42 46 47 43; 557 46 50 51 47; 558 50 54 55 51; 559 54 58 59 55
144. 560 62 66 67 63; 561 66 70 71 67; 562 70 74 75 71; 563 74 78 79 75
145. 564 82 86 87 83; 565 86 90 91 87; 566 90 94 95 91; 567 94 98 99 95
146. 568 102 106 107 103; 569 106 110 111 107; 570 110 114 115 111
147. 571 114 118 119 115; 572 122 126 127 123; 573 126 130 131 127
148. 574 130 134 135 131; 575 134 138 139 135; 576 142 146 147 143
149. 577 146 150 151 147; 578 150 154 155 151; 579 154 158 159 155
150. 580 162 166 167 163; 581 166 170 171 167; 582 170 174 175 171
151. 583 174 178 179 175; 584 163 167 168 164; 585 167 171 172 168
152. 586 171 175 176 172; 587 175 179 180 176; 588 143 147 148 144
153. 589 147 151 152 148; 590 151 155 156 152; 591 155 159 160 156
154. 592 123 127 128 124; 593 127 131 132 128; 594 131 135 136 132
155. 595 135 139 140 136; 596 103 107 108 104; 597 107 111 112 108
156. 598 111 115 116 112; 599 115 119 120 116; 600 83 87 88 84; 601 87 91 92 88
157. 602 91 95 96 92; 603 95 99 100 96; 604 63 67 68 64; 605 67 71 72 68
158. 606 71 75 76 72; 607 75 79 80 76; 608 43 47 48 44; 609 47 51 52 48
159. 610 51 55 56 52; 611 55 59 60 56; 612 23 27 28 24; 613 27 31 32 28
160. 614 31 35 36 32; 615 35 39 40 36; 616 3 7 8 4; 617 7 11 12 8; 618 11 15 16 12
161. 619 15 19 20 16; 620 182 185 186 183; 621 185 188 189 186; 622 188 191 192 189
162. 623 191 194 195 192
163. ELEMENT PROPERTY
164. 516 TO 623 THICKNESS 0.15
165. DEFINE MATERIAL START

166. ISOTROPIC CONCRETE
167. E 2.17185E+007
168. POISSON 0.17
169. DENSITY 23.5616
170. ALPHA 1E-005
171. DAMP 0.05
172. TYPE CONCRETE
173. STRENGTH FCU 27579
174. END DEFINE MATERIAL
175. MEMBER PROPERTY AMERICAN
176. 1 TO 41 72 TO 112 143 TO 183 214 TO 254 285 TO 325 PRIS YD 0.5 ZD 0.4
177. 42 TO 71 113 TO 142 184 TO 213 255 TO 284 326 TO 515 624 TO 626 -
178. 627 PRIS YD 0.75 ZD 0.5
179. CONSTANTS
180. MATERIAL CONCRETE ALL
181. SUPPORTS
182. 206 TO 225 FIXED
183. DEFINE WIND LOAD
*** NOTE: If any floor diaphragm is present in the model Wind Load definition should be defined after Floor Diaphragm definition.
Otherwise wind
load generation may be unsuccessful during analysis.
184. TYPE 1 WIND LOAD
185. INT 2.01 2.14 2.231 2.341 2.474 2.65 2.739 HEIG 10 15 20 30 50 100 150
186. EXP 1 JOINT 1 TO 225
187. LOAD 1 LOADTYPE DEAD TITLE DL
188. SELFWEIGHT Y -1 LIST 1 TO 515 624 TO 627
189. MEMBER LOAD
190. 42 TO 68 113 TO 139 184 TO 210 255 TO 281 326 TO 352 356 TO 483 500 TO 515 -
191. 624 TO 627 UNI GY -15.21
192. FLOOR LOAD
193. YRANGE 3.5 28 FLOAD 5.5 XRANGE 0 19 ZRANGE 0 6 GY
NOTE about Floor/OneWay Loads/Weights.
Please note that depending on the shape of the floor you may
have to break up the FLOOR/ONEWAY LOAD into multiple commands. For details please refer to Technical Reference Manual
Section 5.32.4.2 Note d and/or "5.32.4.3 Note f.
194. YRANGE 0 28 FLOAD 5.5 XRANGE 0 19 ZRANGE 6 12 GY
195. YRANGE -3.5 28 FLOAD 5.5 XRANGE 0 19 ZRANGE 12 18 GY
196. LOAD 2 LOADTYPE LIVE TITLE LL
197. FLOOR LOAD
198. YRANGE 3.5 24.5 FLOAD 3 XRANGE 0 19 ZRANGE 0 6 GY
199. YRANGE 0 24.5 FLOAD 3 XRANGE 0 19 ZRANGE 6 12 GY
200. YRANGE -3.5 24.5 FLOAD 3 XRANGE 0 19 ZRANGE 12 18 GY
201. LOAD 3 LOADTYPE WIND TITLE WL X+
202. WIND LOAD X 1 TYPE 1 XR 0 19 YR 0 28 ZR 0 6
203. WIND LOAD X 1 TYPE 1 XR 0 19 YR -3.5 28 ZR 6 12
204. WIND LOAD X 1 TYPE 1 XR 0 19 YR -7 28 ZR 12 18
205. LOAD 4 LOADTYPE WIND TITLE WL X -
206. WIND LOAD X -1 TYPE 1 YR 0 28 ZR 0 6
207. WIND LOAD X -1 TYPE 1 YR 0 28 ZR 6 12
208. WIND LOAD X -1 TYPE 1 YR -7 28 ZR 12 18
209. LOAD 6 LOADTYPE WIND TITLE WL Z -
210. WIND LOAD Z -1 TYPE 1 XR 0 19 YR -7 28
211. LOAD 7 GENERATED INDIAN CODE GENRAL_STRUCTURES 1
212. REPEAT LOAD
213. 1 1.5 2 1.5
214. LOAD 8 GENERATED INDIAN CODE GENRAL_STRUCTURES 2
215. REPEAT LOAD
216. 1 1.2 2 1.2 3 1.2
217. LOAD 9 GENERATED INDIAN CODE GENRAL_STRUCTURES 3
218. REPEAT LOAD
219. 1 1.2 2 1.2 4 1.2

P R O B L E M S T A T I S T I C S

NUMBER OF JOINTS 225 NUMBER OF MEMBERS 519
NUMBER OF PLATES 108 NUMBER OF SOLIDS 0
NUMBER OF SURFACES 0 NUMBER OF SUPPORTS 20
SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER ORIGINAL/FINAL BAND-WIDTH= 205/ 27/ 168 DOF
TOTAL PRIMARY LOAD CASES = 25, TOTAL DEGREES OF FREEDOM = 1230
TOTAL LOAD COMBINATION CASES = 0 SO FAR.
SIZE OF STIFFNESS MATRIX = 207 DOUBLE KILO-WORDS REQRD/AVAIL. DISK SPACE = 16.4/ 165754.7 MB

MAXIMUM DISPLACEMENTS (CM /RADIANS) (LOADING 9) MAXIMUMS AT NODE

X = -2.68762E+00 180

Y = -5.26466E-01 164
Z = 5.69772E-01 180
RX= 7.20523E-04 17
RY= -3.87175E-04 1
RZ= 6.34454E-04 43

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. 10
GENERATED INDIAN CODE GENRAL_STRUCTURES 4
CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
(FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)
X = 0.994179849E+01
Y = 0.694526676E+01
Z = 0.952222938E+01
** NOTE: MOMENT BALANCE DOES NOT CONSIDER SECONDARY EFFECTS OF P-Delta or Direct Analysis **

STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. 11
GENERATED INDIAN CODE GENRAL_STRUCTURES 5
CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
(FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)
X = 0.994179849E+01
Y = 0.694526676E+01
Z = 0.952222938E+01
CENTER OF FORCE BASED ON Z FORCES ONLY (METE).
STATIC LOAD/REACTION/EQUILIBRIUM SUMMARY FOR CASE NO. 12
GENERATED INDIAN CODE GENRAL_STRUCTURES 6
CENTER OF FORCE BASED ON X FORCES ONLY (METE).
(FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)
X = 0.000000000E+00
Y = 0.126780483E+02
Z = 0.941554729E+01
CENTER OF FORCE BASED ON Y FORCES ONLY (METE).
(FORCES IN NON-GLOBAL DIRECTIONS WILL INVALIDATE RESULTS)
X = 0.994179849E+01
Y = 0.694526676E+01
Z = 0.952222938E+01