International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

# Design and Sustainability of an Earthquake Resistant G+3 Residential Building

**U.V. Narayana Rao, G.Yaswanth Kumar, K Srinivasa Rao**

***Abstract:*** ***In structural building it is fundamental that the vision belief system of the designer in his plan stage meets in its execution. Its additionally essential to guarantee that so as to meet this necessity the measurement, materials and so on… , don't surpass according to the need, along these lines increasing the cost and request to be a finished designer. Tall structure, modern and business building which have a perplexing geometry are hard to examine and plan physically. In this manner it is very to utilize STAAD.PRO programming for the examination and structure. The standard goal of this venture is to investigation and plan of a multistoried G+3 building utilizing staad.pro. the structure has an all out developed zone of sq meter . Plan of the structure is created utilizing auto CAD. The plan includes load counts physically and examining the entire structure by STAAD.pro. The structure strategies utilized in STAAD-PRO investigation are limit state configuration fitting in with Indian standard code of training for configuration shafts, segments, and footings. The structure of part is completed utilizing sp16 configuration helps for strengthened cement and IS 456-2000 plain and fortified solid code of training. Nitty gritty basic drawing of the shafts, sections and balance are set up after all checks. The whole structure is an encircled structure with segments and pillars assembled solidly, framing a system. The investigation of the confined structure is done utilizing STAAD.pro .The casing comprises of pillars and segments .A model is created of the encircled structure and loads are applied on the individuals. The loadings are received according to IS 875-1987 Design of burdens for structures and structures.***

***Keywords : High rise building, industrial and commercial building complex geometry, STAD PRO software, load calculations, design of beams, columns, and footings, IS 456-2000 plain and reinforced concrete code of practice etc***

## I. INTRODUCTION

The main aim of this paper involves analysis and design of multistoried G+3 Building using a very popular designing software staad.pro .we have chosen STAAD.Pro because of its following advantages: STAAD.PRO highlights a best in class UI, perception instruments, ground-breaking examination and structure motors with cutting edge limited component and structure to representation and result check, staad.

Manuscript received on March 15, 2020.
Revised Manuscript received on March 24, 2020.
Manuscript published on March 30, 2020.

* Correspondence Author

**U.V.Narayana Rao*,** Civil Engineering Department V R Siddhartha Engineering College , Vijayawada, India.,

**G Yaswanth Kumar,** Civil Engineering Department V R Siddhartha Engineering College, Vijayawada, India.

**K Srinivasa Rao**, Mechanical Engineering Department V R Siddhartha Engineering College , Vijayawada, India



pro is the experts decision for steel, solid, timber, aluminum and cold framed steel plan of low and tall structures, ducts, petrochemical plants, burrows, scaffolds, heaps and significantly more. The STAAD.PRO Graphical UI: It is utilized to produce the model, which would then be able to be investigated utilizing the STAAD.engine After examination and configuration is finished, the GUI can likewise be utilized to see the outcomes graphically.

The STAAD ANALYSIS AND DESIGN ENGINE: It is a universally useful figuring motor for basic examination and incorporated steel, solid, timber, and aluminum structure.

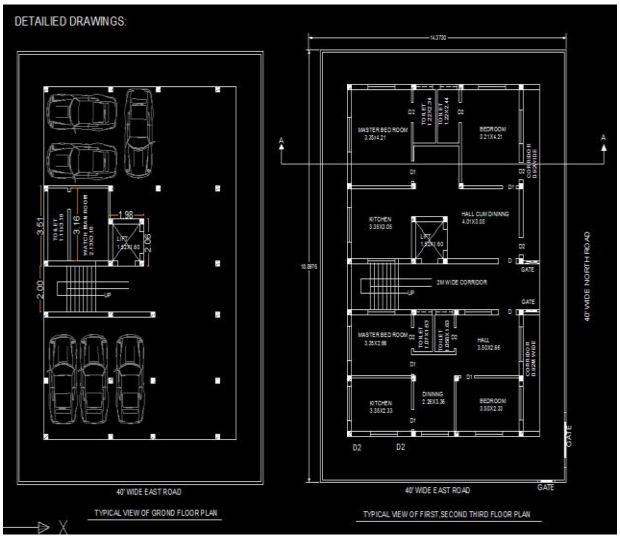
To start with we have tackled some example issues utilizing staad.pro and checked the precision of the outcomes with manual figurings .The outcomes were to fulfillment and were exact. Basic examination contains the arrangement of physical laws and numerical required to contemplate and predicts the conduct of structures. Basic examination can be seen all the more uniquely as a technique to drive the building configuration process or demonstrate the adequacy of a structure without a reliance on straightforwardly testing it.

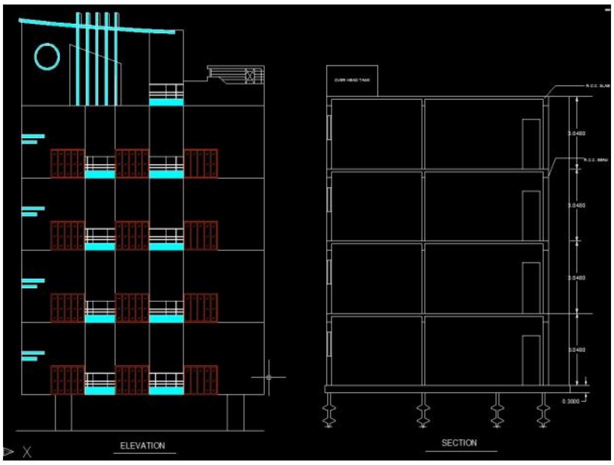
To play out an exact investigation a basic specialist must decide such data as basic burdens, geometry, bolster conditions and material properties . The aftereffects of such an examination ordinarily incorporate help responses, stresses and removals .This data is then contrasted with criteria that show the states of disappointment. Progressed auxiliary examination may analyze dynamic reaction, dependability, and non straight conduct.

The point of the plan is the accomplishment of a worthy likelihood that structures being planned will perform sufficiently during their expected life .With a fitting level of wellbeing, they ought to continue all the heaps and misshapenings of ordinary development and use and havce satisfactory toughness and satisfactory protection from the impacts of seismic .Structure and basic components will regularly be planned by limit state technique . Record ought to be taken of acknowledged hypotheses test and experience and the need to structure for toughness.

The structure of the structure is reliant upon the base prerequisite as recommended in the Indian standard codes. The base necessities relating to the basic security of structures are being secured by method for setting down least plan loads which must be expected for dead loads ,forced burdens , and other outer burdens , the structure would be required to hold up under. Severe adjustment to stacking principles prescribed right now it is trusted, won't just guarantee the auxiliary security of the structures which are being planned

**Architectural Plans:**



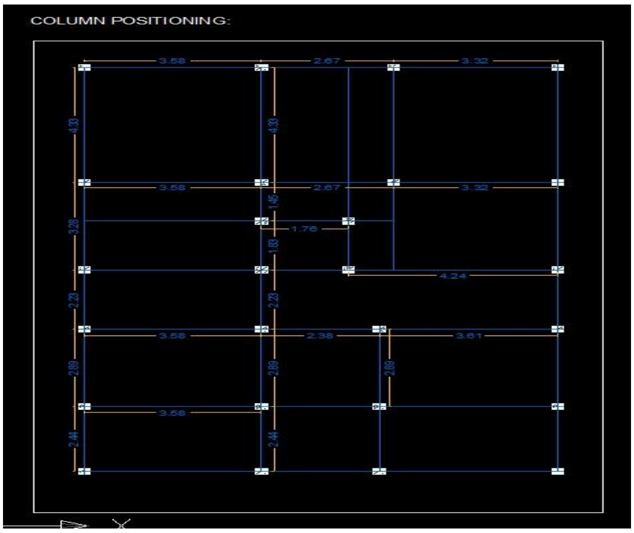




**Fig 1 Column positioning**

**Loads Considered:**

**Dead Loads:**

.All the lasting developments of the structure the dead loads. The dead burden contains the heaviness of the dividers, segments floor completes, bogus roofs ,bogus floors and the other lasting development in the structures .The dead loads might be determined from the components of different individuals and their unit loads , the unit loads of plain concrete and fortified cement made with sand and rock might be taken as 24kn/m and 25kn/m separately.

**Imposed Loads:**

Forced burden is created by the planned use or inhabitance of a structure including the heaviness of versatile segments, upset and focused burdens, load because of effect and vibration and residue loads. Forced burdens do exclude stacks because of wind, seismic action, day off, loads forced because of temperature changes to which the structure will be exposed to crawl and shrinkage of the structure ,the differential settlements to which the structure may experience

**Seismic Load:**

The plan sidelong power will be first processed for the structure all in all .This parallel power will at that point be dispersed to the different floor levels. The general structure power along these lines acquired at each floor level will at that point be circulated to singular sidelong load opposing components relying upon the floor stomach activity.

**Load combinations:**

The structure has been broke down for the heap blends thinking about all the past burdens in legitimate proportion. Mix of self weight ,dead burden, live burden and seismic burden was mulled over as per IS – CODE 875(part5).

## Analysis of G+3 RCC Frame Building Using Staad.Pro:

### 1.1 Generation of Member Property :

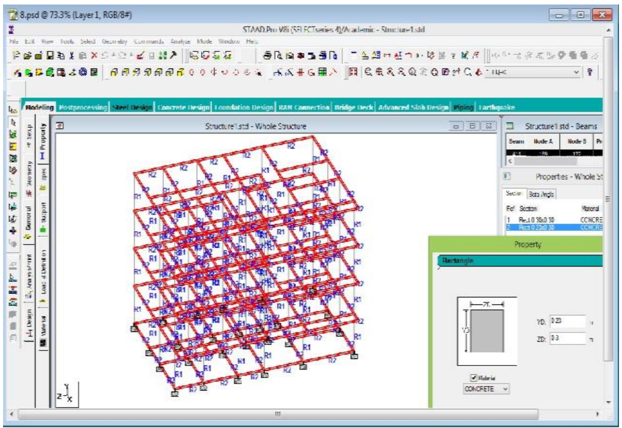


**Fig. 2 Generation of Member Property**

Age of part property should be possible in STADD. Professional by utilizing the window as above. The part segment is chosen and the Dimensions have been specified. The bars having measurements of 0.23x0.3m and segments having a component of 0.3x0.3m.

### 1.2 Supports :

The Base backings of the structure were allotted as fixed. The backings were created by utilizing STADD. Master bolster generator.

*Retrieval Number: F9546038620/2020©BEIESP*
*DOI: 10.35940/ijrte.F9546.038620*
*Journal Website: www.ijrte.org*



*Published By:*
*Blue Eyes Intelligence Engineering*
*& Sciences Publication*

### 1.3 Materials For The Structure:

The materials for the structure were indicated as concrete with their different constants according to standard IS code of training

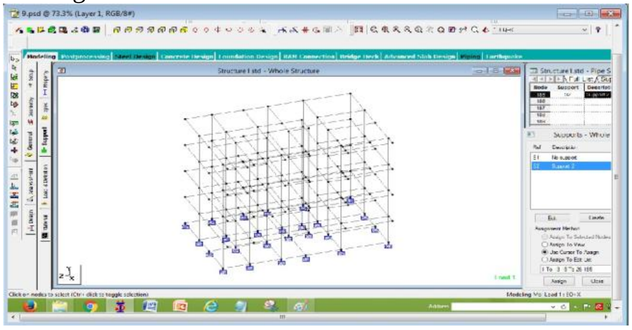


**Fig. 3 Fixing supports of the structure**

### 1.4 Loadings:

The loadings were determined mostly physically and rest was produced utilizing STAAD.Pro load generator. The stacking cases are categorized as:

**Self weight**

The self weight of the structure can be generated by **STAAD.Pro** itself.

**Dead load from the slab**

**Live load**

**Seismic load**

**Load combinations**

**Dead Load:**

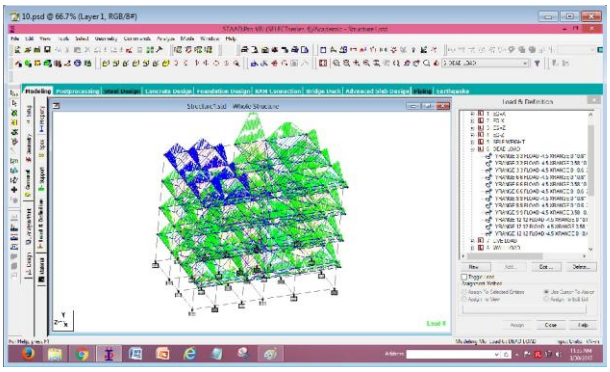


**Fig 4 The structure under dead Load**

**Live Load:**

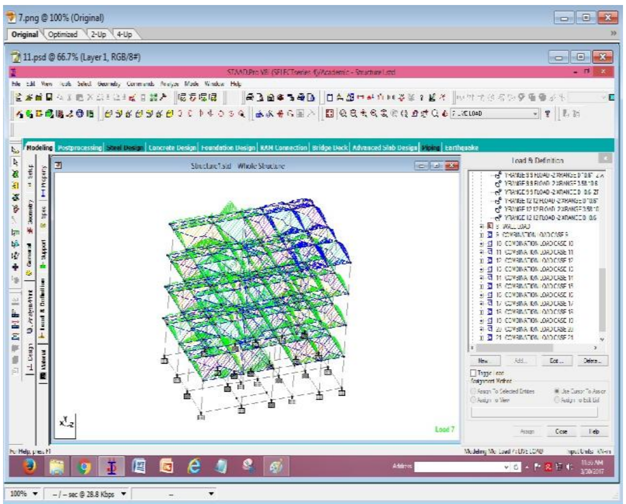


**Fig 5 The structure under live Load**

**Seismic load**

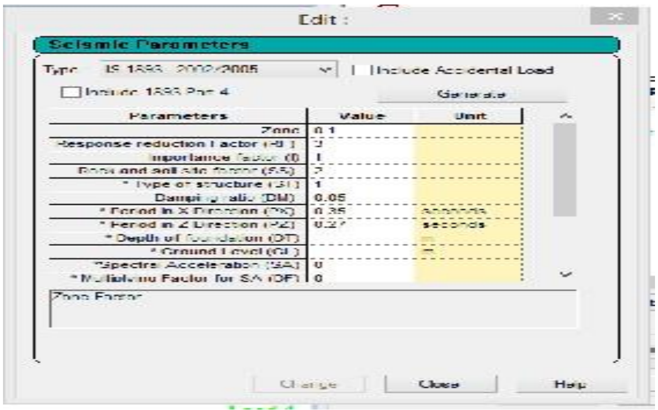


**Fig 6 Seismic load**

### 2.0 Design of G+3 RCC Framed Building Using STAAD.PRO:

### 2.1 Design of Slab:

In the current venture two kinds of chunks are structured in particular rooftop piece . rooftop chunk is a nonstop section on the highest point of the structure which is otherwise called porch. By and large porch has less live burden and it is vacant in more often than not aside from in certain events. Consequently all the rooftop pieces are planned as two path section for the simple game plan of the support and simplicity of the work.

### 2.2 Design of Beam:

A fortified solid shaft ought to have the option to oppose tractable compressive and shear stresses initiated in it by the heaps on the beam. Concrete is genuinely solid in pressure yet frail in strain. Plain solid pillars are in this manner constrained in conveying limit by the low rigidity .steel is solid in strain. Along these lines the shortcoming of cement is overwhelmed by the arrangement of strengthening steel in the pressure zone around the solid to make a fortified solid shaft. The shaft is broke down first so as to figure the interior activities, for example, bowing minute and shear power. The profundity of the shaft is taken by L/10 – L/6.

### 2.3 Design of Column:

A segment as a rule might be characterized as a part conveying diect pivotal burden which causes compressive worries of such greatness that these anxieties to a great extent control its structure. The heaps and minutes in segments in an edge are unique. Every one of the segment is required to be structured independently. Anyway when whole structure is to be planned , there will be various different segments alongside every one of the above segments to shape a gathering. All the sections are exposed to pivotal burdens and uniaxial twisting minute. Thusly in the current plan all sections are fit as a fiddle

### 2.4 Design of Foundation:

Establishment configuration includes a dirt report to build up the most suitable kind of establishment and a basic plan to decide balance measurements and required measure of support.

Since compressive quality of the dirt is commonly a lot more vulnerable than that of the solid , the contact territory between the dirt and the balance is a lot bigger than that of the sections and dividers. Contingent upon the bearing limit of the dirt, planning of structure will be finished.

**2.5 Design of Staircase:**

Stairs comprise of steps organized in an arrangement for motivation behind offering access to various floors of a structure. The area of stairs requires great and cautious thought. In the current plan hound legged staircase is planned.

**STAAD PRO Input Command File:**

Staad Space
Start Job Information
End Job Information
Input Width 79
Unit Meter KN
Joint Coordinates

1 0 0 0; 2 3.58 0 0; 3 0 0 4.33; 4 6.25 0 0; 5 9.57 0 0; 6 3.58 0 4.33;
7 6.25 0 4.33; 8 9.57 0 4.33; 9 3.58 0 5.78; 10 5.34 0 5.78; 11 3.58 0 7.61;
12 5.34 0 7.61; 13 0 0 7.61; 15 0 0 9.84; 16 3.58 0 9.84; 17 5.96 0 9.84;
18 9.57 0 9.84; 19 0 0 12.73; 20 3.58 0 12.73; 21 5.96 0 12.73;
22 9.57 0 12.73; 23 0 0 15.17; 24 3.58 0 15.17; 25 5.96 0 15.17;
26 9.57 0 15.17; 27 0 3 0; 28 3.58 3 0; 29 0 3 4.33; 30 6.25 3 0; 31 9.57 3 0;
32 3.58 3 4.33; 33 6.25 3 4.33; 34 9.57 3 4.33; 35 3.58 3 5.78; 36 5.34 3 5.78;
37 3.58 3 7.61; 38 5.34 3 7.61; 39 0 3 7.61; 41 0 3 9.84; 42 3.58 3 9.84;
43 5.96 3 9.84; 44 9.57 3 9.84; 45 0 3 12.73; 46 3.58 3 12.73; 47 5.96 3 12.73;
48 9.57 3 12.73; 49 0 3 15.17; 50 3.58 3 15.17; 51 5.96 3 15.17;
52 9.57 3 15.17; 53 0 6 0; 54 3.58 6 0; 55 0 6 4.33; 56 6.25 6 0; 57 9.57 6 0;
58 3.58 6 4.33; 59 6.25 6 4.33; 60 9.57 6 4.33; 61 3.58 6 5.78; 62 5.34 6 5.78;
63 3.58 6 7.61; 64 5.34 6 7.61; 65 0 6 7.61; 67 0 6 9.84; 68 3.58 6 9.84;
69 5.96 6 9.84; 70 9.57 6 9.84; 71 0 6 12.73; 72 3.58 6 12.73; 73 5.96 6 12.73;
74 9.57 6 12.73; 75 0 6 15.17; 76 3.58 6 15.17; 77 5.96 6 15.17;
78 9.57 6 15.17; 79 0 9 0; 80 3.58 9 0; 81 0 9 4.33; 82 6.25 9 0; 83 9.57 9 0;
84 3.58 9 4.33; 85 6.25 9 4.33; 86 9.57 9 4.33; 87 3.58 9 5.78; 88 5.34 9 5.78;
89 3.58 9 7.61; 90 5.34 9 7.61; 91 0 9 7.61; 93 0 9 9.84; 94 3.58 9 9.84;
95 5.96 9 9.84; 96 9.57 9 9.84; 97 0 9 12.73; 98 3.58 9 12.73; 99 5.96 9 12.73;
100 9.57 9 12.73; 101 0 9 15.17; 102 3.58 9 15.17; 103 5.96 9 15.17;
104 9.57 9 15.17; 105 0 12 0; 106 3.58 12 0; 107 0 12 4.33; 108 6.25 12 0;
109 9.57 12 0; 110 3.58 12 4.33; 111 6.25 12 4.33; 112 9.57 12 4.33;
113 3.58 12 5.78; 114 5.34 12 5.78; 115 3.58 12 7.61; 116 5.34 12 7.61;
117 0 12 7.61; 119 0 12 9.84; 120 3.58 12 9.84; 121 5.96 12 9.84;
122 9.57 12 9.84; 123 0 12 12.73; 124 3.58 12 12.73; 125 5.96 12 12.73;
126 9.57 12 12.73; 127 0 12 15.17; 128 3.58 12 15.17; 129 5.96 12 15.17;
130 9.57 12 15.17; 131 6.25 3 2.53; 132 3.58 3 2.53; 133 4.915 3 0;
134 4.915 3 2.53; 135 10.6 3 0; 136 10.6 3 4.33; 137 10.61 3 7.61;
138 10.6 3 9.84; 139 10.6 3 12.73; 140 10.6 3 15.17; 141 4.77 3 9.84;
142 3.58 3 11.64; 143 5.96 3 11.64; 144 4.77 3 11.64; 145 6.25 6 2.53;
146 3.58 6 2.53; 147 4.915 6 0; 148 4.915 6 2.53; 149 10.6 6 0;
150 10.6 6 4.33; 151 10.61 6 7.61; 152 10.6 6 9.84; 153 10.6 6 12.73;
154 10.6 6 15.17; 155 4.77 6 9.84; 156 3.58 6 11.64; 157 5.96 6 11.64;
158 4.77 6 11.64; 159 6.25 9 2.53; 160 3.58 9 2.53; 161 4.915 9 0;
162 4.915 9 2.53; 163 10.6 9 0; 164 10.6 9 4.33; 165 10.61 9 7.61;
166 10.6 9 9.84; 167 10.6 9 12.73; 168 10.6 9 15.17; 169 4.77 9 9.84;
170 3.58 9 11.64; 171 5.96 9 11.64; 172 4.77 9 11.64; 177 10.6 12 0;
178 10.6 12 4.33; 179 10.61 12 7.61; 180 10.6 12 9.84; 181 10.6 12 12.73;
182 10.6 12 15.17; 183 1.27 0 7.61; 184 1.27 0 4.33; 185 9.57 0 7.61;
186 9.57 3 7.61; 187 9.57 6 7.61; 188 9.57 9 7.61; 189 9.57 12 7.61;

**Member Incidences**

1 1 2; 2 2 4; 3 4 5; 4 5 8; 7 18 22; 8 22 26; 9 1 3; 10 3 13; 11 13 15;
12 15 19; 13 19 23; 14 23 24; 15 24 25; 16 25 26; 17 3 184; 18 6 7; 19 7 8;
20 13 183; 21 11 12; 23 15 16; 24 16 17; 25 17 18; 26 19 20; 27 20 21;
28 21 22; 29 24 20; 30 20 16; 31 16 11; 32 25 21; 33 21 17; 34 2 6; 35 4 7;
36 9 10; 37 10 12; 38 9 11; 39 1 27; 40 2 28; 41 3 29; 42 4 30; 43 5 31;
44 6 32; 45 7 33; 46 8 34; 47 9 35; 48 10 36; 49 11 37; 50 12 38; 51 13 39;
53 15 41; 54 16 42; 55 17 43; 56 18 44; 57 19 45; 58 20 46; 59 21 47; 60 22 48;
61 23 49; 62 24 50; 63 25 51; 64 26 52; 65 27 28; 66 28 133; 67 30 31;
68 31 34; 71 44 48; 72 48 52; 73 27 29; 74 29 39; 75 39 41; 76 41 45; 77 45 49;
78 49 50; 79 50 51; 80 51 52; 81 29 32; 82 32 33; 83 33 34; 84 39 37; 85 37 38;
87 41 42; 88 42 141; 89 43 44; 90 45 46; 91 46 47; 92 47 48; 93 50 46;

94 46 142; 95 42 37; 96 51 47; 97 47 143; 98 28 132; 99 30 131; 100 35 36;
101 36 38; 102 35 37; 103 27 53; 104 28 54; 105 29 55; 106 30 56; 107 31 57;
108 32 58; 109 33 59; 110 34 60; 111 35 61; 112 36 62; 113 37 63; 114 38 64;
115 39 65; 117 41 67; 118 42 68; 119 43 69; 120 44 70; 121 45 71; 122 46 72;
123 47 73; 124 48 74; 125 49 75; 126 50 76; 127 51 77; 128 52 78; 129 53 54;
130 54 147; 131 56 57; 132 57 60; 135 70 74; 136 74 78; 137 53 55; 138 55 65;
139 65 67; 140 67 71; 141 71 75; 142 75 76; 143 76 77; 144 77 78; 145 55 58;
146 58 59; 147 59 60; 148 65 63; 149 63 64; 151 67 68; 152 68 155; 153 69 70;
154 71 72; 155 72 73; 156 73 74; 157 76 72; 158 72 156; 159 68 63; 160 77 73;
161 73 157; 162 54 146; 163 56 145; 164 61 62; 165 62 64; 166 61 63; 167 53 79;
168 54 80; 169 55 81; 170 56 82; 171 57 83; 172 58 84; 173 59 85; 174 60 86;
175 61 87; 176 62 88; 177 63 89; 178 64 90; 179 65 91; 181 67 93; 182 68 94;
183 69 95; 184 70 96; 185 71 97; 186 72 98; 187 73 99; 188 74 100; 189 75 101;
190 76 102; 191 77 103; 192 78 104; 193 79 80; 194 80 161; 195 82 83;
196 83 86; 199 96 100; 200 100 104; 201 79 81; 202 81 91; 203 91 93; 204 93 97;
205 97 101; 206 101 102; 207 102 103; 208 103 104; 209 81 84; 210 84 85;
211 85 86; 212 91 89; 213 89 90; 215 93 94; 216 94 169; 217 95 96; 218 97 98;
219 98 99; 220 99 100; 221 102 98; 222 98 170; 223 94 89; 224 103 99;
225 99 171; 226 80 160; 227 82 159; 228 87 88; 229 88 90; 230 87 89;
231 79 105; 232 80 106; 233 81 107; 234 82 108; 235 83 109; 236 84 110;
237 85 111; 238 86 112; 239 87 113; 240 88 114; 241 89 115; 242 90 116;
243 91 117; 245 93 119; 246 94 120; 247 95 121; 248 96 122; 249 97 123;
250 98 124; 251 99 125; 252 100 126; 253 101 127; 254 102 128; 255 103 129;
256 104 130; 257 105 106; 259 108 109; 260 109 112; 263 122 126; 264 126 130;
265 105 107; 266 107 117; 267 117 119; 268 119 123; 269 123 127; 270 127 128;
271 128 129; 272 129 130; 273 107 110; 274 110 111; 275 111 112; 276 117 115;
277 115 116; 279 119 120; 281 121 122; 282 123 124; 283 124 125; 284 125 126;
285 128 124; 287 120 115; 288 129 125; 292 113 114; 293 114 116; 294 113 115;
295 131 33; 296 132 32; 297 133 30; 298 132 134; 299 134 131; 300 133 134;
301 31 135; 302 135 136; 303 136 137; 304 137 138; 305 138 139; 306 139 140;
307 52 140; 308 48 139; 309 44 138; 311 34 136; 312 141 43; 313 142 42;
314 143 43; 315 142 143; 316 141 144; 317 145 59; 318 146 58; 319 147 56;
320 155 69; 321 156 68; 322 157 69; 323 146 148; 324 148 145; 325 147 148;
326 57 149; 327 149 150; 328 150 151; 329 151 152; 330 152 153; 331 153 154;
332 78 154; 333 156 157; 334 155 158; 335 159 85; 336 160 84; 337 161 82;
338 169 95; 339 170 94; 340 171 95; 341 160 162; 342 162 159; 343 161 162;
344 83 163; 345 163 164; 346 164 165; 347 165 166; 348 166 167; 349 167 168;
350 104 168; 351 170 171; 352 169 172; 362 109 177; 363 177 178; 364 178 179;
365 179 180; 366 180 181; 367 181 182; 368 130 182; 371 60 150; 373 70 152;
374 74 153; 375 86 164; 377 96 166; 378 100 167; 379 112 178; 381 122 180;
382 126 181; 383 106 108; 384 120 121; 385 120 124; 386 121 125; 387 106 110;
388 108 111; 389 183 11; 390 184 6; 391 184 183; 392 6 9; 393 12 185;
394 8 185; 395 185 18; 396 38 186; 397 186 137; 398 34 186; 399 186 44;
400 64 187; 401 187 151; 402 60 187; 403 187 70; 404 90 188; 405 188 165;
406 86 188; 407 188 96; 408 116 189; 409 189 179; 410 112 189; 411 189 122;
412 185 186; 413 186 187; 414 187 188; 415 188 189;

Define Material Start
Isotropic Concrete
E 2.17185e+007
Poisson 0.17
Density 23.5616
Alpha 1e-005
Damp 0.05
End Define Material
Member Property American
39 To 51 53 To 64 103 To 115 117 To 128 167 To 179 181 To 192 231 To 243 245 -
246 To 256 412 To 415 Pris Yd 0.3 Zd 0.3
1 To 4 7 To 21 23 To 38 65 To 68 71 To 85 87 To 102 129 To 132 135 To 149 -
151 To 166 193 To 196 199 To 213 215 To 230 257 259 260 263 To 277 279 281 -
282 To 285 287 288 292 To 309 311 To 352 362 To 368 371 373 To 375 -
377 To 379 381 To 411 Pris Yd 0.23 Zd 0.3
Constants
Material Concrete All
Supports
1 To 13 15 To 26 185 Fixed
Define 1893 Load
Zone 0.1 Rf 3 I 1 Ss 2 St 1 Dm 0.05 Px 0.35 Pz 0.27
Selfweight 1
Member Weight
1 To 4 7 To 10 12 To 16 65 To 68 71 To 74 76 To 80 84 87 To 89 129 To 132 –

135 To 138 140 To 144 148 151 To 153 193 To 196 199 To 202 204 To 208 212 -
213 215 To 217 277 292 To 294 297 312 319 320 337 338 394 395 398 399 402 -
403 406 407 Uni 10
38 81 83 90 92 To 94 96 98 99 145 147 154 156 To 158 160 162 163 209 211 218 -
220 To 222 224 226 227 295 296 298 To 300 313 To 318 321 To 325 333 To 336 -
339 To 343 351 352 391 392 Uni 5
257 259 265 266 268 To 272 301 To 307 326 To 332 344 To 350 362 To 368 -
383 Uni 3.1
11 31 75 95 139 159 203 223 267 287 Uni 15
Load 1 Loadtype Seismic Title Eq+X
1893 Load X 1
Load 2 Loadtype Seismic Title Eq-X
1893 Load X -1
Load 3 Loadtype Seismic Title Eq+Z
1893 Load Z 1
Load 4 Loadtype Seismic Title Eq-Z
1893 Load Z -1

## III. DESIGN RESULTS AND ANALYSIS

**Beam Results :**

B E A M D E S I G N R E S U L T S
M20 Fe500 (Main) Fe415 (Sec.)
LENGTH: 3320.0 mm SIZE: 300.0 mm X 230.0 mm
COVER: 25.0 mm Staad Space - Page No. 274
Summary Of Reinf. Area (Sq.Mm) Section 0.0 mm 830.0 mm 1660.0 mm 2490.0 mm 3320.0 mm TOP 766.15 176.71 101.49 251.80 902.02 Reinf. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) Bottom 362.87 259.17 163.01 259.68 514.76 Reinf. (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm) (Sq. mm)
Summary Of Provided Reinf. Area
Section 0.0 mm 830.0 mm 1660.0 mm 2490.0 mm 3320.0 mm
Top 7-12í 3-12í 3-12í 3-12í 8-12í
Reinf. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 2 layer(s)
Bottom 5-10í 4-10í 3-10í 4-10í 7-10í
REINF. 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s) 1 layer(s)
Shear 2 legged 8í 2 legged 8í 2 legged 8í 2 legged 8í 2legged 8í
Reinf. @ 100 mm c/c @ 100 mm c/c @ 100 mm c/c @ 100 mm c/c @ 100 mm c/c
Shear Design Results at Distance D (Effective Depth) From Face of the Support
Shear Design Results at 345.0 mm away from Start Support VY = 51.20 MX = 0.06 LD= 15 Provide 2 Legged 8í @100 mm c/ hear Design Results At 345.0 Mm Away From End Support
VY = -54.95 MX = -0.08 LD= 14
Provide 2 Legged 8í @ 100 mm c/c

**Design of Two Way Rectangular Slab:**
**Design Steps:**

$\frac{ly}{lx} = \frac{4.21}{3.35} = 1.256$

Hence, the slab is to be designed as a two way slab.

**1. Thickness of Slab:**

Assume effective depth (d) = Span/28 = 3350/28 = 119.64mm Adopt effective depth (d) =120mm
Overall depth (D) = 145mm.

**2. Effective Span :**

L= 3.35+(0.23/2)+(0.115/2)=3.52
Ly= 4.21+(0.23/2)+(0.115/2)= 4.38
$\frac{ly}{lx} = \frac{4.38}{3.52} = 1.24$

**3. Loads**:

Self weight of slab = 0.145×25=3.625 KN/$m^2$
Live load = 2 KN/$m^2$
Floor Finish = 1 KN/$m^2$
Total Load = 6.625 KN/$m^2$
Factored Load (Wu) = 1.5×6.625=9.9375 KN/$m^2$

**4.Design Moments and Shear Forces :**

This slab corresponds case 4. Of Table-26 of IS-456 as Two adjacent edges are continuous.

$\alpha$ ( -ve) = $0.060+\frac{(0.060-0.065)}{(1.2-1.3)} \times (1.24-1.2)$
$\alpha$ ( -ve) =0.062
$\alpha$ (+ve) = $0.045+\frac{(0.045-0.049)}{(1.2-1.3)} \times (1.24-1.2)$
$\alpha$ (+ve) = 0.046
$\alpha$y (-ve) = 0.047
$\alpha$y(+ve) = 0.035
Mu (-ve) = $0.062 \times 9.94 \times (3.52)^2$ = 7.63 KN-m
Mu (+ve) = $0.046 \times 9.94 \times (3.52)^2$ = 5.75 KN-m
Muy (-ve) = $0.047 \times 9.94 \times (3.52)^2$ = 5.78 KN-m
Muy (+ve) = $0.035 \times 9.94 \times (3.52)^2$ = 4.30 KN-m
Vu = $\frac{Wu \times l}{2} = \frac{9.94 \times 3.52}{2}$ = 17.49 KN

**5.Minimum Depth Required :**

The minimum depth required to resist bending moment
Mu = 0.138 fck $bd^2$
$7.63\times10^6 = 0.138 \times 20 \times 1000 \times d^2$
d = 52.57mm < 120mm
Hence provided depth is adequate

6.**Reinforcement** :

Along Short span(-ve) @ support
Mu = 0.87 fy Ast d$\left(\frac{1-fyAst}{fck\,b\,d}\right)$
$7.36\times10^6 = 0.87\times415\times Ast\times120\left(\frac{1-415*Ast}{20*1000*120}\right)$
Ast = 181.82 $mm^2$
Using 16mm diameter bars,Spacing of bars (S)
S = $\frac{ast}{Ast}\times1000 = \frac{\frac{\pi}{4}\times16^2}{181.82}\times1000$ = 431.96mm
Maimum Spacing is
3d = 3×120= 360mm
300mm which ever is less
Hence,Provide 16mm diameter bars at 300 mm $^c/_c$
Along shorter span(+ve) @ mid span
Mu = 0.87 fy Ast d$\left(\frac{1-fyAst}{fck\,b\,d}\right)$
$5.75\times10\times6 = 0.87\times415\times Ast\times120\left(\frac{1-415*Ast}{20*1000*120}\right)$
Ast = 135.90 $mm^2$
Minimum Reinforcement = Ast,min = 0.12 % of Gross Area = (0.12/100)×145 = 174 $mm^2$

Adopt Ast = 174 $mm^2$
Using 8mm diameter bars,Spacing of bars (S)
S = $\frac{ast}{Ast}$×1000 = $\frac{\frac{\pi}{4}\times 10^2}{174}$×1000 = 451.37 mm
Maimum Spacing is
3d = 3×120= 360mm
300mm which ever is less
Hence, provide 10mm diameter bars at 300mm $c/c$
Along y –direction (-ve BM)
AS the moment is same (+5.75 KN-m ) 8mm diameter bars at 280 mm $c/c$
AS the +ve BM is still less, Provide Minimum Reinforcement as calculated above,i.e., 16mm diameter bars at 280 mm $c/c$

**7.Reinforcement in Edge Strip**:
Ast =0.12 % of Gross Area
= (0.12/100)×145 = 174 $mm^2$
Using 8mm diameter bars,Spacing of bars (S)
S = $\frac{ast}{Ast}$×1000 = $\frac{\frac{\pi}{4}\times 10^2}{174}$×1000 = 451.37mm
Maimum Spacing is
5d = 5×120= 600mm
450mm which ever is less
Hence,Provide 10mm diameter bars at 450 mm $c/c$ in Edge strips in both directions

**8.Torsion Reinforcement :**
At the corner,where both both edges are discontinuous,area of reinforcement in each layer
$A_t$ =3/4 $Ast_x$ = ¾×174 = 130.5$mm^2$
Distance over which torsion reinforcement is to be provided = 1/5th Short span
=1/5×lx =3520/5 = 704 mm
Using 6 mm bars,Spacing
S = $\frac{ast}{At}$×1000 = $\frac{\frac{\pi}{4}\times 8^2}{130.5}$×1000 = 385.47 mm
Hence,Provide mm diameter bars at 300 mm $c/c$ in four Layers at corner A Where both edges are Discontinuous.
At the corner where one edge is discontinuous and one edge is continuous,Area of Reinforcement in each layer
$A_t$ =1/2×3/4 $Ast_x$ = ½×¾×174 = 65.25$mm^2$
S = $\frac{ast}{At}$×1000 = $\frac{\frac{\pi}{4}\times 8^2}{65.25}$×1000 = 770.35mm
Hence,Provide 8mm diameter bars at 300 mm $c/c$ at corners Where one edge is discontinuous and one edge is continuous.
At the corner,where both edges are continuous,torsion reinforcement is not required.

**9.Check for Deflection:**
For Simply continuous Slabs Basic value of l/d ratio is 20
Modification factor for tension steel $F_1$
% of steel = 0.12
Fs = 0.58×fy =0.58×415 =240 N/$mm^2$
From Fig.4 of IS 456,Modification factor = 1.6
Maximum permitted l/d ratio = 1.6×26 = 41.6
l/d provided =3520/120 = 29.33 < 41.6
Hence deflection control is safe.

**Design of Cantilever Slab**

**Design Steps:**

**1. Thickness of Slab:**
Assume effective depth (d) = Span/10 = 920/10 = 92mm
Adopt effective depth (d) =120mm
Overall depth (D) = 145mm.
The depth D may be gradually reduced to 90mm at the free end.

**2. Loads:**
Self weight of slab = (0.145+0.1)/2×25=3.0625 KN/$m^2$
Live load = 2 KN/$m^2$
Floor Finish = 1 KN/$m^2$
Total Load = 6.0625 KN/$m^2$
Factored Load (Wu) = 1.5×6.0625=9.09375 KN/$m^2$

**3.Design Moments and Shear Forces:**
Mu = $\frac{Wu\times l^2}{2}$ = $\frac{9.094\times 0.92^2}{2}$ = 3.85KN-m
Vu=Wu×l =9.094×0.92 =8.37 KN

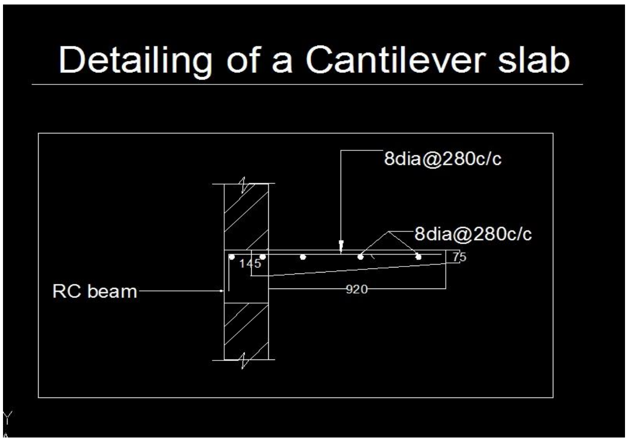
**4.Minimum Depth Required :**
The minimum depth required to resist bending moment
Mu = 0.138 fck $bd^2$
$3.85\times 10^6$ =0.138 ×20×1000×$d^2$
d = 37.34mm < 120mm
Hence provided depth is adequate.

5.Reinforcement:
Mu = 0.87 fy Ast d( $\frac{1-fyAst}{fck\,b\,d}$ )
$3.85\times10^6$=0.87×415×Ast×120($\frac{1-415*Ast}{20*1000*120}$ )
Ast = 90.26$mm^2$
Minimum Reinforcement = Ast,min = 0.12 % of Gross Area
= (0.12/100)×145 = 174 $mm^2$
Adopt Ast = 174 $mm^2$
Using 8mm diameter bars,Spacing of bars (S)
S = $\frac{ast}{Ast}$×1000 = $\frac{\frac{\pi}{4}\times 8^2}{174}$×1000 = 288.88 mm
Maimum Spacing is
3d = 3×120= 360mm
300mm which ever is less
Hence,Provide 8mm diameter bars at 280 mm $c/c$

6.Distribution Reinforcement:
Minimum Reinforcement = Ast,min = 0.12 % of Gross Area
= (0.12/100)×145 = 174 $mm^2$
Adopt Ast = 174 $mm^2$
Using 8mm diameter bars,Spacing of bars (S)
S = $\frac{ast}{Ast}$×1000 = $\frac{\frac{\pi}{4}\times 8^2}{174}$×1000 = 288.88 mm
Maimum Spacing is
5d = 5×120= 600mm
450mm which ever is less
Hence,Provide 8mm diameter bars at 280 mm $c/c$ in transverse directions.

7.Anchorage Lengh at Support:
The anchorage length required at the support is given by
Ld = (0.87×fy×ø/4×$\tau_{bd}$) =( 0.87×415×8/4×1.2×1.6)
= 376mm

8.Check for Deflection:
For Simply continuous Slabs Basic value of l/d ratio is 7
Modification factor for tension steel $F_1$
% of steel = 0.12
Fs = 0.58×fy =0.58×415 =240 N/mm $^2$
From Fig.4 of IS 456,Modification factor = 1.6
Maximum permitted l/d ratio = 1.6×20 = 11.2
l/d provided =920/120 = 7.67 < 11.2
Hence deflection control is safe.




**Stair case Design :**

**Proportioning of stair case :**

Dimensions of stair = 2m x 5m
Height of the floor = 3m
Height of one flight = 3/2=1.5m
Rise, R = 150 mm
Tread T = 270 mm
No of Rises = 1500/150 = 10 No's
Hence,No of treads = 10-1 = 9 No's
Adopt width of stair = 1.2

**Length of going :**

For 9 treads,the length required = width of tread x no of treads = 0.27 x 0.9 =2.43 m
Width of landing = (5-2.43)/2 = 1.285m

**Effective Length of flight :**

Effective Length = Beam / 2 +Going + Beam/2 = 0.23 / 2 + 2.43 +0.23/2 = 2.66 m

**Effective Length of Landing Slab :**

Effective Length = Beam/2 +Width of Landing = 0.23/2 + 1.285 = 1.4 m

**Depth of Waist slab :**

Assume Overall Depth of waist slab is 150 mm
Effective Depth = D – cover – ø/2
= 150 – 20 -12/2 = 124 mm

**Calculation of Loads :**

Live Load = 2 $KN/m^2$
Floor finish = 0.6 $KN/m^2$

Weight of the waist Slab = $D\sqrt{1+(\frac{R}{T})^2}$ x 25

$= 0.15\sqrt{1+(\frac{0.15}{0.27})^2}$ x 25 = 4.29 KN/m

Weight of steps $=(\frac{\frac{1}{2}RT}{T})$ x 25 = R x $\frac{25}{2}$

$=(\frac{\frac{1}{2}\times 0.15\times 0.27}{0.27})$ x 25 = 1.875 $KN/m^2$

Total Load = 8.765 $KN/m^2$
Factored Load (Wu )= 13.14 $KN/m^2$

**Factored Bending Moment :**

$Mu = \frac{Wul^2}{8} = \frac{13.14\times 5.23^2}{8}$ = 44.92 KN-m

**Minimum Depth Required :**

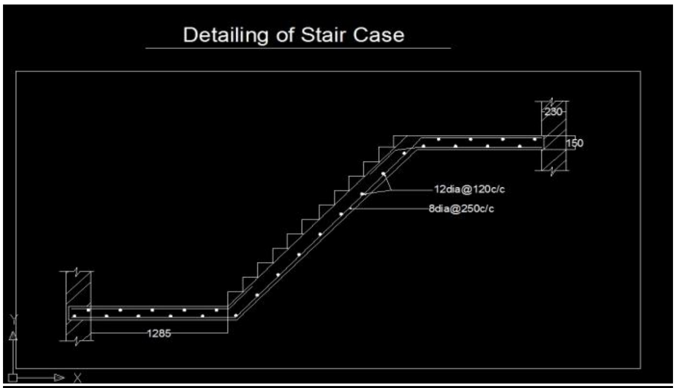
The minimum depth required to resist bending moment
$Mu = 0.138\ fck\ bd^2$
$44.92\times10^6 = 0.138\times20\times1000\times d^2$
d = 127.57mm < 150mm
Hence provided depth is adequate.

**Tension Reinforcement :**

$Mu = 0.87\ fy\ Ast\ d(\frac{1-fyAst}{fck\ b\ d})$
$44.92\times10^6=0.87\times415\times Ast\times120(\frac{1-415*Ast}{20*1000*150})$
Ast = 889.75 $mm^2$
Minimum Reinforcement = Ast,min = 0.12 % of Gross Area
= (0.12/100)×150 x 1000 = 180 $mm^2$( $Ast_{req} > Ast_{min}$)
Using 12 mm diameter bars,Spacing of bars (S)
$S = \frac{ast}{Ast}\times1000 = \frac{\frac{\pi}{4}\times12^2}{889.75}\times1000$ = 127.11 mm
Maimum Spacing is
1.3xd = 3×125= 375 mm
2.300mm which ever is less
Hence,Provide 12 mm diameter bars at 120 mm c/c

**Distribution Reinforcement:**

Minimum Reinforcement = Ast,min = 0.12 % of Gross Area
= (0.12/100)×150 x 1000 = 180 $mm^2$
Adopt Ast = 180 $mm^2$
Using 8mm diameter bars,Spacing of bars (S)
$S = \frac{ast}{Ast}\times1000 = \frac{\frac{\pi}{4}\times8^2}{180}\times1000$ = 279.25 mm
Maimum Spacing :1. 5d = 5×125= 625 mm, 2. 450mm which ever is less
Hence,Provide 8mm diameter bars at 250 mm $^c/_c$.




## IV. CONCLUSIONS

STAAD PRO has the ability to figure the fortification required for any solid area. The program contains various parameters which are planned according to IS 456. Bars are intended for flexure ,shear and torsion.

**Design for flexure:**

Most extreme hanging and hoarding minutes are determined for all dynamic burden cases at every one of the previously mentioned segments. Every one of these segments are intended to oppose both of these basic hanging and hoarding minutes. Any place the rectangular segment is insufficient as separately strengthened segment, doubly fortified segment is attempted.

**Design for shear:**

Shear support is determined to oppose both shear and torsional minutes. Shear limit computation at various segments without the shear fortification depends on the genuine ductile support gave to deal with the equalization shear powers following up on these segments.

**Beam design output:**

The default configuration yield of the bar contains flexural and shear support gave along the length of the pillar.

*Retrieval Number: F9546038620/2020©BEIESP*
*DOI: 10.35940/ijrte.F9546.038620*
*Journal Website: www.ijrte.org*



*Published By:*
*Blue Eyes Intelligence Engineering*
*& Sciences Publication*

**Column design:**
Segments are intended for hub powers and biaxial minutes at the finishes. All dynamic burden cases are tried to compute fortification. The stacking which yield most extreme support is known as the basic burden. Segment configuration is accomplished for square segment. Square segments are structured with fortification conveyed on each side similarly for the areas under uni-pivotal minute. Every single significant measure for choosing longitudinal and transverse fortification as stipulated by IS 456 have been dealt with in the segment structure of staad.

## REFERENCES


1. Benjamin C. McLellan, Ross P. Williams, Janine Lay, Arie van Riessen and Glen D. Corder "Expenses And Carbon Emissions for Geo polymer Pastes in Comparison to Ordinary Portland Cement" Journal of Cleaner Production, Science Direct, 2011
2. 2 B.Singh, Ishwarya G., M. Gupta, S.K. Bhattacharyya"Geopolymer Concrete: An audit of some ongoing improvements", Journal of Construction and building materials, Science Direct, 2015.
3. Djwantoro Hardjito, Steenie E. Wallah, Dody M. J. Sumajouw, and B.Vijaya Rangan "On the Development of Fly Ash-Based Geopolymer Concrete", Journal of American Concrete Institute (ACI), 2004.
4. D.V. Reddy, Jean-Baptiste Edouard and Khaled Sobhan "Solidness of Fly Ash–Based Geopolymer Structural Concrete in the Marine Environment", Journal of American Society for Civil Engineers (ASCE), 2013.
5. Fernando Pacheco-Torgal, Joa˜o Castro-Gomes, SaidJalali "Soluble base initiated folios: A survey Part 1. Verifiable foundation, wording, response components and hydration items" Journal of Construction and Building Materials, Science Direct, 2008.
6. G.S. Manjunath, Radhakrishna, C. Giridhar, Mahesh Jadhav " Compressive Strength Development in Ambient Cured Geo-polymer Mortar",International Journal of Earth Sciences and Engineering, 2011.
7. H. M. Khater "Impact of Calcium on Geopolymerization of Aluminosilicate Wastes", Journal of American Society for Civil Engineers (ASCE), 2012.
8. Mallikarjuna Rao, G., Gunneswara Rao, T.D., 2015. Last setting time and compressive quality of flyash and ggbs based geopolymer glue and mortar Arab J Sci Eng. 40(11), 3067..
9. M. Sofi, J.S.J. van Deventer, P.A. Mendis, G.C. Lukey "Designing properties of inorganic polymer cements (IPCs)", Journal of Cement and Concrete Research, Science Direct, 2007.
10. N A Lloyd and B V Rangan "Geopolymer Concrete with Flyash", Second International Conference on Sustainable Construction Materials and Technologies, 2010.
11. P. Chindaprasirt, T. Chareerat, S. Hatanaka and T. Cao "High-Strength Geopolymer Using FineHigh-Calcium Fly Ash", Journal of American Society For Civil Engineers (ASCE), 2011.
12. Ramin Hosseini Kupaei, U.Johnson Alengaram, Mohd Zamin Bin Jumaat "A Review on Fly Ash-Based Geopolymer Concrete",Electronic Journal of Structural Engineering, 2013.
13. Thunuguntla, C.S., and Gunneswara Rao, T.D., 2018. Evaluation on Strength Characteristics of Alkali-Activated GGBFS with Low Concentrations of Sodium Hydroxide. Iranian Journal of Science and Technology Transactions of Civil Engineering. Pp 1-13.
14. Venu, M., and Rao, T.G., 2017. Tie-repression parts of fly debris GGBS based geopolymer solid short sections. Development and Building Materials. 151, 28-35


## AUTHORS PROFILE


**U. V. Narayana Rao** is currently working as an Assistant Professor in the Civil Engineering Department in V R Siddhartha Engineering College with M.Tech Degree and published 9 papers into reputed International Journals.

**G. Yaswanth Kumar** is currently working as an Assistant Professor in the Civil Engineering Department in V R Siddhartha Engineering College with M.Tech Degree and published 8 papers into reputed International Journals.

**K Srinivasa Rao** is currently working as an Assistant Professor in the Mechanical Engineering Department in V R Siddhartha Engineering College with M.Tech Degree and published 15 papers into reputed International Journals.