

TINJAUAN STANDART KESTABILAN TOWER NG STANDAR 30 METER TERHADAP BEBAN GEMPA DINAMIS DENGAN BERBAGAI SITUS KELAS TANAH SESUAI SNI 1726-2012

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Submission date: 19-Mar-2021 06:19PM (UTC-0700)

Submission ID: 1537471271

File name: NAMIS_DENGAN_BERBAGAI_SITUS_KELAS_TANAH_SESUAI_SNI_1726-2012.pdf (335.81K)

Word count: 3905

Character count: 18040

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**TINJAUAN STANDART KESTABILAN TOWER NG STANDAR 30 METER
TERHADAP BEBAN GEMPA DINAMIS DENGAN BERBAGAI SITUS KELAS
TANAH SESUAI SNI 1726-2012**

(Study kasus Tower NG Standart 30 m, Kabupaten Jember)

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Abstract

The development of world telecommunications is growing very rapidly occur today, requires the telecommunications provider to provide a means of expanding the reach of mobile phone signal and internet signal in the form of 2G, 3G and 4G. With it the necessary means of supporting specialized tower BTS (Base Transceiver Station) to carry the antenna at a certain height.

In planning the establishment of the BTS tower. The load effect in the form of self weight live load and wind load. But necessary review of the value of the Twist, Sway, and Displacement due to earthquake loads that occur with a variety of site classes of the soil in the form of rock soil, hard soil, medium soil and soft soil in accordance with SNI 1726-2012.

Keywords : BTS Tower, value of Twist, Sway, and Displacement, SNI 1726-2012

1. PENDAHULUAN

Perkembangan dunia telekomunikasi yang berkembang sangat pesat terjadi dewasa ini, menuntut para provider telekomunikasi untuk berlomba-lomba merebut hati banyak para konsumen. Salah satu wujud untuk merebut hati para konsumen adalah dengan perluasan jangkauan sinyal telefon seluler dan sinyal internet dalam bentuk 2G, 3G dan 4G. Keberadaan sinyal telefon dan sinyal internet yang kuat dikarenakan adanya antenna pemancar sinyal ataupun antenna penerima sinyal di wilayah jangkauan area tersebut. Antenna ini akan berfungsi dengan jangkauan yang sesuai dengan kapasitasnya, apabila antenna tersebut terletak diketinggian tertentu. Untuk mensiasati keberadaan antenna yang harus dipasang dalam ketinggian tertentu, mengharuskan pembangunan tower BTS (Base Transceiver Station). BTS adalah bagian dari network element GSM yang berhubungan langsung dengan Mobile Station (MS). Beban yang mempengaruhi Tower BTS adalah beban tower itu sendiri, beban hidup dan beban angin karena pengaruh perbandingan ketinggian dan lebar struktur yang sangat besar. Namun pada pengaplikasian di lapangan dimana penempatan tower BTS yang dilakukan di seluruh wilayah Indonesia dengan situs kelas tanan yang benar-benar ragam maka perlunya di analisa akibat beban gempa yang terjadi. Sehingga kita bisa menganalisa berapa besar nilai *Displacement* yang terjadi saat gempa agar tidak melebihi nilai yang diijinkan. Sehingga dapat ditentukan rumusan masalah Bagaimana pengaruh beban gempa terhadap nilai *Twist*, *Sway*, dan *Displacement* yang terjadi pada struktur tower BTS. Bagaimana pengaruh situs kelas tanah yang beraneka ragam terhadap nilai *Twist*, *Sway*, dan *Displacement* yang terjadi pada struktur tower BTS saat terjadi gempa dan Berapa besar pengaruh *Displacement* pada arah x,y,z yang terjadi akibat beban gempa.

2. METODE PENELITIAN

Data Umum

Perencanaan struktur baja dan konstruksi tower, antara lain :

1. EIA-222F "Structural Standards for Steel Antenna Tower and Antenna Supporting Structure."
2. American Institute of Steel Construction (AISC).
3. American Society For Testing And Materials (ASTM).
4. The fabrication and materials of the tower will be according to the relevant Indonesian Standard and/or Japanese Industrial Standard.
5. American Concrete Institute (ACI 48RM-99)
6. SNI 1726-2012 Tata Cara Perencanaan Struktur Bangunan Gedung Dan Non Gedung
7. Aplikasi Sap 2000 V.14, MS tower V6.02

Perancangan Struktur Atas

Data – data yang diperlukan, berupa :

1. Tinggi Menara : 30.00 meter
2. Material
 - a. Angle & Plate Fy 245, Fu 400
 - b. Bolt Fy 600, Fu 800
 - c. Anchor Fy 245, Fu 400
3. Elevasi Tower : 0.0 meter Above Ground Level
4. Kecepatan Angin Maksimum (V). Dalam desain struktur menara, angin dasar (mil tercepat) kecepatan diambil: $V = 120 \text{ km/jam} = 33.33 \text{ m/detik}$.
5. Kecepatan Angin Operasional (V) Untuk analisis Pemindahan, kecepatan angin dasar (mil tercepat) diambil: $V = 84 \text{ km/jam} = 23.33 \text{ m/detik}$.

Twist / puntiran = 0.5°

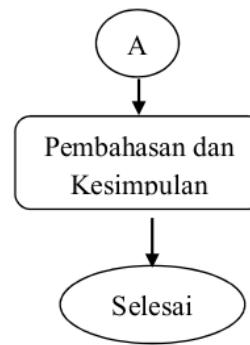
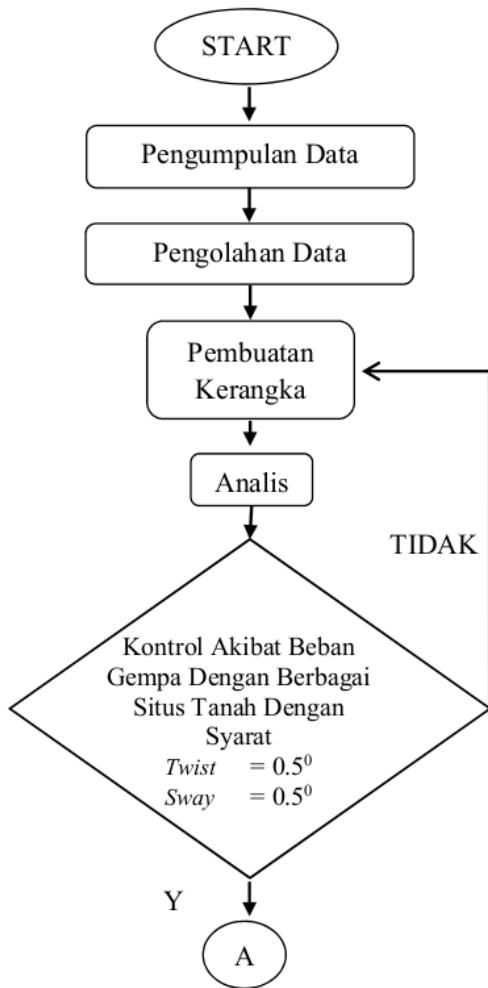
Sway / goyangan = 0.5°

Displacement / Perpindahan =

H/200

6. Beban Antenna
- Satu Ring Mounting Antena Disk Diameter (-) pada elevasi $\pm 28\text{ m}$.
 - Sembilan Sectoral Antena Disk Diameter 2.5 m pada elevasi $\pm 28\text{ m}$.
 - Sembilan Antenna RRU pada elevasi $\pm 25.0\text{ m}$.
 - Enam Antenna Microwave pada elevasi $\pm 24.0\text{ m}$.

Flowchart Tahap Perencanaan



3. HASIL DAN PEMBAHASAN Data Perencanaan

- Tinggi Menara : 30.00 meter
- Material
 - Angle & Plate Fy 245, Fu 400
 - Bolt Fy 600, Fu 800
 - Anchor Fy 245, Fu 400
- Elevasi Tower : 0.0 meter Above Ground Level 21
- Dimensi Profil Menggunakan Baja Siku Sama Kaki

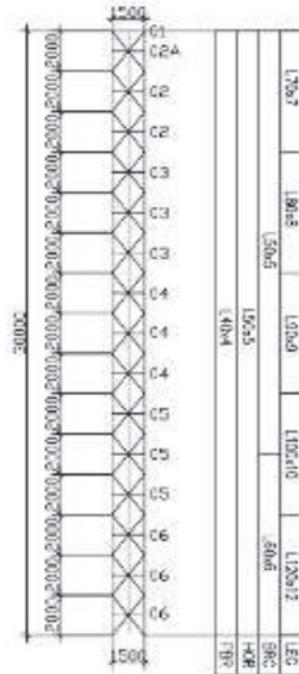
Tabel 1 Profil Baja Siku Sama Kaki

| No | Lebar Hadap | Lebar Sisi | Lebar Sisi | Panjang |
|----|-------------|------------|------------|---------|
| 1 | 100 | 10 | 10 | 300 |
| 2 | 120 | 10 | 10 | 300 |
| 3 | 140 | 10 | 10 | 300 |
| 4 | 160 | 10 | 10 | 300 |
| 5 | 180 | 10 | 10 | 300 |
| 6 | 200 | 10 | 10 | 300 |
| 7 | 220 | 10 | 10 | 300 |
| 8 | 240 | 10 | 10 | 300 |
| 9 | 260 | 10 | 10 | 300 |
| 10 | 280 | 10 | 10 | 300 |
| 11 | 300 | 10 | 10 | 300 |

- Beban Antenna
 - Satu Ring Mounting Antena Disk Diameter (-), berat 2.5 kg pada elevasi $\pm 28\text{ m}$.
 - Sembilan Sectoral Antena Disk Diameter 2.5 m, berat 40 kg pada elevasi $\pm 28\text{ m}$.
 - Sembilan Antenna RRU Disk Diameter(-), berat 25 kg pada elevasi $\pm 25.0\text{ m}$.
 - Enam Antenna Microwave Disk Diameter (0.6), berat 30 kg pada elevasi. $\pm 24.0\text{ m}$.

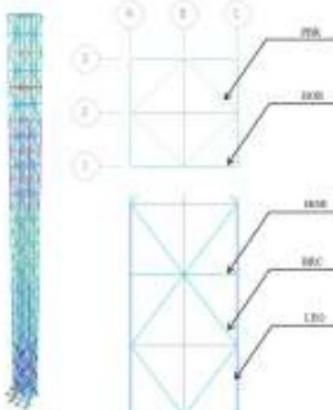
Pemodelan Struktur

- Penempatan profil profil baja siku sama kaki pada struktur tower.



Gambar 1 Pemodelan Struktur Tower

- Pemodelan struktur menggunakan aplikasi SAP 2000 V.14



Gambar 2 Pemodelan Struktur Tower Pada Sap 2000V.14

Penempatan Beban Antena

Tabel 2 Penempatan Beban Antena

| No. | Level | Disk Diameter | Antennas | Kes. |
|-----|-------|---------------|---------------|------|
| 1 | 1st | 2.5 | Ring Mounting | |
| 2 | 2nd | 40 | Sectoral | |
| 3 | 3rd | 40 | Sectoral | |
| 4 | 4th | 40 | Sectoral | |
| 5 | 5th | 40 | Sectoral | |
| 6 | 6th | 40 | Sectoral | |
| 7 | 7th | 40 | Sectoral | |
| 8 | 8th | 40 | Sectoral | |
| 9 | 9th | 40 | Sectoral | |
| 10 | 10th | 40 | Sectoral | |
| 11 | 11th | 40 | Sectoral | |
| 12 | 12th | 40 | Sectoral | |
| 13 | 13th | 40 | Sectoral | |
| 14 | 14th | 40 | Sectoral | |
| 15 | 15th | 40 | Sectoral | |
| 16 | 16th | 40 | Sectoral | |
| 17 | 17th | 40 | Sectoral | |
| 18 | 18th | 40 | Sectoral | |
| 19 | 19th | 40 | Sectoral | |
| 20 | 20th | 40 | Sectoral | |
| 21 | 21st | 30 | RRU | |
| 22 | 22nd | 30 | RRU | |
| 23 | 23rd | 30 | RRU | |
| 24 | 24th | 30 | RRU | |
| 25 | 25th | 30 | RRU | |
| 26 | 26th | 30 | RRU | |
| 27 | 27th | 30 | RRU | |
| 28 | 28th | 30 | RRU | |
| 29 | 29th | 30 | RRU | |
| 30 | 30th | 30 | RRU | |
| 31 | 31st | 30 | RRU | |
| 32 | 32nd | 30 | RRU | |
| 33 | 33rd | 30 | RRU | |
| 34 | 34th | 30 | RRU | |
| 35 | 35th | 30 | RRU | |
| 36 | 36th | 30 | RRU | |
| 37 | 37th | 30 | RRU | |
| 38 | 38th | 30 | RRU | |
| 39 | 39th | 30 | RRU | |
| 40 | 40th | 30 | RRU | |
| 41 | 41st | 30 | RRU | |
| 42 | 42nd | 30 | RRU | |
| 43 | 43rd | 30 | RRU | |
| 44 | 44th | 30 | RRU | |
| 45 | 45th | 30 | RRU | |
| 46 | 46th | 30 | RRU | |
| 47 | 47th | 30 | RRU | |
| 48 | 48th | 30 | RRU | |
| 49 | 49th | 30 | RRU | |
| 50 | 50th | 30 | RRU | |
| 51 | 51st | 30 | RRU | |
| 52 | 52nd | 30 | RRU | |
| 53 | 53rd | 30 | RRU | |
| 54 | 54th | 30 | RRU | |
| 55 | 55th | 30 | RRU | |
| 56 | 56th | 30 | RRU | |
| 57 | 57th | 30 | RRU | |
| 58 | 58th | 30 | RRU | |
| 59 | 59th | 30 | RRU | |
| 60 | 60th | 30 | RRU | |
| 61 | 61st | 30 | RRU | |
| 62 | 62nd | 30 | RRU | |
| 63 | 63rd | 30 | RRU | |
| 64 | 64th | 30 | RRU | |
| 65 | 65th | 30 | RRU | |
| 66 | 66th | 30 | RRU | |
| 67 | 67th | 30 | RRU | |
| 68 | 68th | 30 | RRU | |
| 69 | 69th | 30 | RRU | |
| 70 | 70th | 30 | RRU | |
| 71 | 71st | 30 | RRU | |
| 72 | 72nd | 30 | RRU | |
| 73 | 73rd | 30 | RRU | |
| 74 | 74th | 30 | RRU | |
| 75 | 75th | 30 | RRU | |
| 76 | 76th | 30 | RRU | |
| 77 | 77th | 30 | RRU | |
| 78 | 78th | 30 | RRU | |
| 79 | 79th | 30 | RRU | |
| 80 | 80th | 30 | RRU | |
| 81 | 81st | 30 | RRU | |
| 82 | 82nd | 30 | RRU | |
| 83 | 83rd | 30 | RRU | |
| 84 | 84th | 30 | RRU | |
| 85 | 85th | 30 | RRU | |
| 86 | 86th | 30 | RRU | |
| 87 | 87th | 30 | RRU | |
| 88 | 88th | 30 | RRU | |
| 89 | 89th | 30 | RRU | |
| 90 | 90th | 30 | RRU | |
| 91 | 91st | 30 | RRU | |
| 92 | 92nd | 30 | RRU | |
| 93 | 93rd | 30 | RRU | |
| 94 | 94th | 30 | RRU | |
| 95 | 95th | 30 | RRU | |
| 96 | 96th | 30 | RRU | |
| 97 | 97th | 30 | RRU | |
| 98 | 98th | 30 | RRU | |
| 99 | 99th | 30 | RRU | |
| 100 | 100th | 30 | RRU | |
| 101 | 101st | 30 | RRU | |
| 102 | 102nd | 30 | RRU | |
| 103 | 103rd | 30 | RRU | |
| 104 | 104th | 30 | RRU | |
| 105 | 105th | 30 | RRU | |
| 106 | 106th | 30 | RRU | |
| 107 | 107th | 30 | RRU | |
| 108 | 108th | 30 | RRU | |
| 109 | 109th | 30 | RRU | |
| 110 | 110th | 30 | RRU | |
| 111 | 111th | 30 | RRU | |
| 112 | 112th | 30 | RRU | |
| 113 | 113th | 30 | RRU | |
| 114 | 114th | 30 | RRU | |
| 115 | 115th | 30 | RRU | |
| 116 | 116th | 30 | RRU | |
| 117 | 117th | 30 | RRU | |
| 118 | 118th | 30 | RRU | |
| 119 | 119th | 30 | RRU | |
| 120 | 120th | 30 | RRU | |
| 121 | 121st | 30 | RRU | |
| 122 | 122nd | 30 | RRU | |
| 123 | 123rd | 30 | RRU | |
| 124 | 124th | 30 | RRU | |
| 125 | 125th | 30 | RRU | |
| 126 | 126th | 30 | RRU | |
| 127 | 127th | 30 | RRU | |
| 128 | 128th | 30 | RRU | |
| 129 | 129th | 30 | RRU | |
| 130 | 130th | 30 | RRU | |
| 131 | 131st | 30 | RRU | |
| 132 | 132nd | 30 | RRU | |
| 133 | 133rd | 30 | RRU | |
| 134 | 134th | 30 | RRU | |
| 135 | 135th | 30 | RRU | |
| 136 | 136th | 30 | RRU | |
| 137 | 137th | 30 | RRU | |
| 138 | 138th | 30 | RRU | |
| 139 | 139th | 30 | RRU | |
| 140 | 140th | 30 | RRU | |
| 141 | 141st | 30 | RRU | |
| 142 | 142nd | 30 | RRU | |
| 143 | 143rd | 30 | RRU | |
| 144 | 144th | 30 | RRU | |
| 145 | 145th | 30 | RRU | |
| 146 | 146th | 30 | RRU | |
| 147 | 147th | 30 | RRU | |
| 148 | 148th | 30 | RRU | |
| 149 | 149th | 30 | RRU | |
| 150 | 150th | 30 | RRU | |
| 151 | 151st | 30 | RRU | |
| 152 | 152nd | 30 | RRU | |
| 153 | 153rd | 30 | RRU | |
| 154 | 154th | 30 | RRU | |
| 155 | 155th | 30 | RRU | |
| 156 | 156th | 30 | RRU | |
| 157 | 157th | 30 | RRU | |
| 158 | 158th | 30 | RRU | |
| 159 | 159th | 30 | RRU | |
| 160 | 160th | 30 | RRU | |
| 161 | 161st | 30 | RRU | |
| 162 | 162nd | 30 | RRU | |
| 163 | 163rd | 30 | RRU | |
| 164 | 164th | 30 | RRU | |
| 165 | 165th | 30 | RRU | |
| 166 | 166th | 30 | RRU | |
| 167 | 167th | 30 | RRU | |
| 168 | 168th | 30 | RRU | |
| 169 | 169th | 30 | RRU | |
| 170 | 170th | 30 | RRU | |
| 171 | 171st | 30 | RRU | |
| 172 | 172nd | 30 | RRU | |
| 173 | 173rd | 30 | RRU | |
| 174 | 174th | 30 | RRU | |
| 175 | 175th | 30 | RRU | |
| 176 | 176th | 30 | RRU | |
| 177 | 177th | 30 | RRU | |
| 178 | 178th | 30 | RRU | |
| 179 | 179th | 30 | RRU | |
| 180 | 180th | 30 | RRU | |
| 181 | 181st | 30 | RRU | |
| 182 | 182nd | 30 | RRU | |
| 183 | 183rd | 30 | RRU | |
| 184 | 184th | 30 | RRU | |
| 185 | 185th | 30 | RRU | |
| 186 | 186th | 30 | RRU | |
| 187 | 187th | 30 | RRU | |
| 188 | 188th | 30 | RRU | |
| 189 | 189th | 30 | RRU | |
| 190 | 190th | 30 | RRU | |
| 191 | 191st | 30 | RRU | |
| 192 | 192nd | 30 | RRU | |
| 193 | 193rd | 30 | RRU | |
| 194 | 194th | 30 | RRU | |
| 195 | 195th | 30 | RRU | |
| 196 | 196th | 30 | RRU | |
| 197 | 197th | 30 | RRU | |
| 198 | 198th | 30 | RRU | |
| 199 | 199th | 30 | RRU | |
| 200 | 200th | 30 | RRU | |
| 201 | 201st | 30 | RRU | |
| 202 | 202nd | 30 | RRU | |
| 203 | 203rd | 30 | RRU | |
| 204 | 204th | 30 | RRU | |
| 205 | 205th | 30 | RRU | |
| 206 | 206th | 30 | RRU | |
| 207 | 207th | 30 | RRU | |
| 208 | 208th | 30 | RRU | |
| 209 | 209th | 30 | RRU | |
| 210 | 210th | 30 | RRU | |
| 211 | 211st | 30 | RRU | |
| 212 | 212nd | 30 | RRU | |
| 213 | 213rd | 30 | RRU | |
| 214 | 214th | 30 | RRU | |
| 215 | 215th | 30 | RRU | |
| 216 | 216th | 30 | RRU | |
| 217 | 217th | 30 | RRU | |
| 218 | 218th | 30 | RRU | |
| 219 | 219th | 30 | RRU | |
| 220 | 220th | 30 | RRU | |
| 221 | 221st | 30 | RRU | |
| 222 | 222nd | 30 | RRU | |
| 223 | 223rd | 30 | RRU | |
| 224 | 224th | 30 | RRU | |
| 225 | 225th | 30 | RRU | |
| 226 | 226th | 30 | RRU | |
| 227 | 227th | 30 | RRU | |
| 228 | 228th | 30 | RRU | |
| 229 | 229th | 30 | RRU | |
| 230 | 230th | 30 | RRU | |
| 231 | 231st | 30 | RRU | |
| 232 | 232nd | 30 | RRU | |
| 233 | 233rd | 30 | RRU | |
| 234 | 234th | 30 | RRU | |
| 235 | 235th | 30 | RRU | |
| 236 | 236th | 30 | RRU | |
| 237 | 237th | 30 | RRU | |
| 238 | 238th | 30 | RRU | |
| 239 | 239th | 30 | RRU | |
| 240 | 240th | 30 | RRU | |
| 241 | 241st | 30 | RRU | |
| 242 | 242nd | 30 | RRU | |
| 243 | 243rd | 30 | RRU | |
| 244 | 244th | 30 | RRU | |
| 245 | 245th | 30 | RRU | |
| 246 | 246th | 30 | RRU | |
| 247 | 247th | 30 | RRU | |
| 248 | 248th | 30 | RRU | |
| 249 | 249th | 30 | RRU | |
| 250 | 250th | 30 | RRU | |
| 251 | 251st | 30 | RRU | |
| 252 | 252nd | 30 | RRU | |
| 253 | 253rd | 30 | RRU | |
| 254 | 254th | 30 | RRU | |
| 255 | 255th | 30 | RRU | |
| 256 | 256th | 30 | RRU | |
| 257 | 257th | 30 | RRU | |
| 258 | 258th | 30 | RRU | |
| 259 | 259th | 30 | RRU | |
| 260 | 260th | 30 | RRU | |
| 261 | 261st | 30 | RRU | |
| 262 | 262nd | 30 | RRU | |
| 263 | 263rd | 30 | RRU | |
| 264 | 264th | 30 | RRU | |
| 265 | 265th | 30 | RRU | |
| 266 | 266th | 30 | RRU | |
| 267 | 267th | 30 | RRU | |
| 268 | 268th | 30 | RRU | |
| 269 | 269th | 30 | RRU | |
| 270 | 270th | 30 | RRU | |
| 271 | 271st | 30 | RRU | |
| 272 | 272nd | 30 | RRU | |
| 273 | 273rd | 30 | RRU | |
| 274 | 274th | 30 | RRU | |
| 275 | 275th | 30 | RRU | |
| 276 | 276th | 30 | RRU | |
| 277 | 277th | 30 | RRU | |

4. Beban Angin

- a. Kecepatan Angin Maksimum (V) Dalam desain struktur menara, angin dasar (mil tercepat) kecepatan diambil : $V = 120 \text{ km/jam} = 33.33 \text{ m/sec}$

$$\text{Tekanan angin } p = \frac{V^2}{16}$$

$$V = 33.33 \text{ m/s}$$

$$P = \frac{33.33^2}{16} \text{ kg/m}^2 = 69.3 \text{ kg/m}^2$$

$$\text{Jarak rangka} = 1.5 \text{ m}$$

$$\text{Sudut} = 0^\circ$$

$$\text{Tekanan angin (w)} = 69.3 \text{ kg/m}^2$$

Koefisien angin tekan untuk

$$\text{rangka (c1)} = 1.6$$

$$\text{Maka } W_1 = c_1 \cdot w \cdot 0.3$$

$$= 1.6 \times 69.3 \times 1.6 = 33.3 \text{ kg/m}$$

- b. Kecepatan Angin Operasional (V). Untuk analisis Pemindahan, kecepatan angin dasar (mil tercepat) diambil : $V = 84 \text{ km/jam} = 23.33 \text{ m/detik}$ Tekanan angin $p = \frac{V^2}{16}$

$$V = 23.33 \text{ m/s } P = \frac{23.33^2}{16} \text{ kg/m}^2$$

$$= 34 \text{ kg/m}^2$$

$$\text{Jarak rangka} = 1.5$$

$$m \text{ Sudut} = 0^\circ$$

$$\text{Tekanan angin (w)} = 34 \text{ kg/m}^2$$

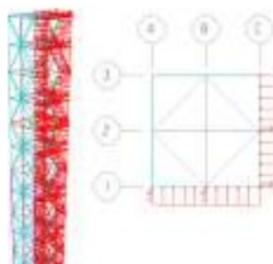
Koefisien angin tekan untuk

$$\text{rangka (c1)} = 1.6$$

$$\text{Maka } W_1 = c_1 \cdot w \cdot 0.3$$

$$= 1.6 \times 34 \times 0.3 = 16.3 \text{ kg/m}$$

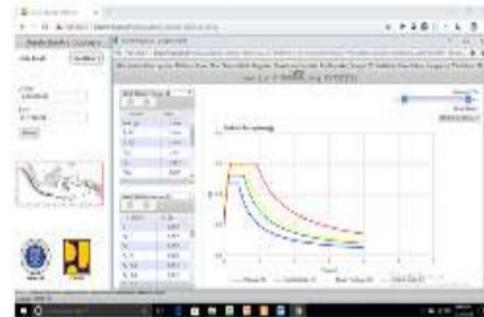
Input beban angin pada arah $0^\circ, 45^\circ, 90^\circ, 135^\circ, 180^\circ, 225^\circ, 270^\circ, 315^\circ$



Gambar 4 Pembebanan Angin Pada Sudut 315° .

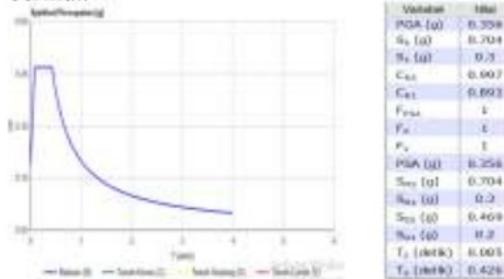
Beban Gempa

Beban Gempa menggunakan Nilai Spektra Gempa pada wilayah Kabupaten Jember dapat diketahui dengan menggunakan [site](http://puskim.pu.go.id/Aplikasi/desain_spektra_indonesia_2011/) http://puskim.pu.go.id/Aplikasi/desain_spektra_indonesia_2011/ dengan Koordinat Kabupaten Jember = $8^\circ 10' 8'' S$ $113^\circ 42' 8'' E$. Hasil Analisa Desain Spektra sebagai berikut.

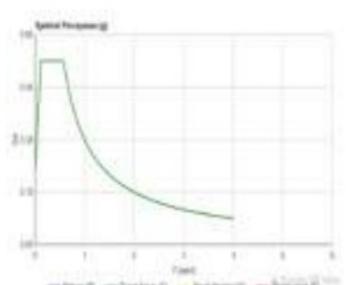


Gambar 5 Desain Spektra Kabupaten Jember

Dari hasil analisa diatas dapat diketahui berbagai situs kelas tanah yang ada sebagai berikut.

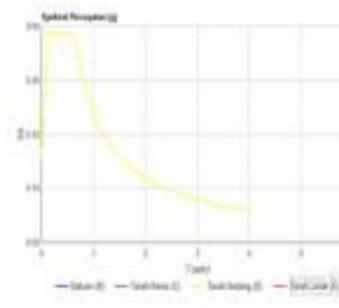


Gambar 6 Jenis Tanah : Batuan



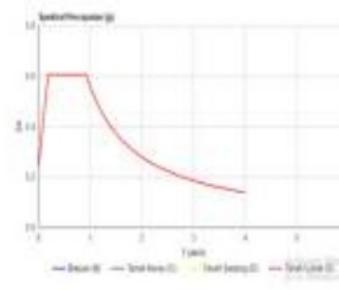
Gambar 7 Jenis Tanah : Keras

| Variabel | Hasil |
|-------------------------|-------|
| PGA (g) | 0.398 |
| S ₀ (g) | 0.704 |
| S ₁ (g) | 0.3 |
| C ₀₁ | 0.997 |
| C ₀₂ | 0.998 |
| F _{PGA} | 1.044 |
| F _R | 1.138 |
| F _W | 1.5 |
| PSA (g) | 0.371 |
| S ₀₁ (g) | 0.707 |
| S ₀₂ (g) | 0.45 |
| S ₀₃ (g) | 0.525 |
| S ₀₄ (g) | 0.3 |
| T ₀₁ (detik) | 0.114 |
| T ₀₂ (detik) | 0.372 |



Gambar 8 Jenis Tanah : Sedang

| Variabel | Hasil |
|-------------------------|-------|
| PGA (g) | 0.386 |
| S ₀ (g) | 0.704 |
| S ₁ (g) | 0.3 |
| C ₀₁ | 0.997 |
| C ₀₂ | 0.998 |
| F _{PGA} | 1.144 |
| F _R | 1.237 |
| F _W | 1.8 |
| PSA (g) | 0.427 |
| S ₀₁ (g) | 0.707 |
| S ₀₂ (g) | 0.54 |
| S ₀₃ (g) | 0.58 |
| S ₀₄ (g) | 0.36 |
| T ₀₁ (detik) | 0.124 |
| T ₀₂ (detik) | 0.62 |



Gambar 9 Jenis Tanah : Lunak

| Variabel | Hasil |
|-------------------------|-------|
| PGA (g) | 0.398 |
| S ₀ (g) | 0.704 |
| S ₁ (g) | 0.3 |
| C ₀₁ | 0.997 |
| C ₀₂ | 0.998 |
| F _{PGA} | 1.033 |
| F _R | 1.292 |
| F _W | 2.79 |
| PSA (g) | 0.387 |
| S ₀₁ (g) | 0.703 |
| S ₀₂ (g) | 0.64 |
| S ₀₃ (g) | 0.68 |
| S ₀₄ (g) | 0.36 |
| T ₀₁ (detik) | 0.101 |
| T ₀₂ (detik) | 0.924 |

c. 4 2D + 1,0E (Tanah sedang)+ L

d. 1,2D + 1,0E (Tanah lunak) + L

6. 0,9D + 1,0W

7. 0,9D + 1,0E

Dimana :

D = Pengaruh dari beban mati.

L = Pengaruh beban hidup

Br = Pengaruh beban hidup tambahan

4 = Beban air hujan

W = Beban angina

E = Pengaruh beban gempa

4

Hasil Analisa Struktur Menggunakan SAP 2000 V.14

1. Hasil Analisa Twist yang terjadi pada tower



Gambar 10 Twist Yang Terjadi Pada Tower

Tabel 3 Twist Yang Terjadi Pada Jenis Tanah Batuan

| Joint Text | Output Case | 1 | | | 2 | | | Kontrol <0.5° |
|------------------|------------------|------------|------------|------------|-----------|-----------|-----------|---------------|
| | | R1 Radians | R2 Radians | R3 Radians | R1 degree | R2 degree | R3 degree | |
| 1 TANAH BATUAN | 0.00042 0.000194 | 4.588E-09 | 0.0024 | 0.0111 | 0.000003 | 0.000003 | 0.000003 | Ok |
| 2 TANAH BATUAN | 0.00042 0.000194 | 4.588E-09 | 0.0024 | 0.0111 | 0.000003 | 0.000003 | 0.000003 | Ok |
| 3 TANAH BATUAN | 0.00042 0.000194 | 2.097E-08 | 0.0024 | 0.0111 | 0.000002 | 0.000002 | 0.000002 | Ok |
| 4 TANAH BATUAN | 0.00042 0.000194 | 2.097E-08 | 0.0024 | 0.0111 | 0.000002 | 0.000002 | 0.000002 | Ok |
| 829 TANAH BATUAN | 0.00042 0.000194 | 4.734E-08 | 0.0024 | 0.0111 | 0.000007 | 0.000007 | 0.000007 | Ok |
| 835 TANAH BATUAN | 0.00042 0.000194 | 4.734E-08 | 0.0024 | 0.0111 | 0.000007 | 0.000007 | 0.000007 | Ok |
| 952 TANAH BATUAN | 0.00042 0.000194 | 4.734E-08 | 0.0024 | 0.0111 | 0.000007 | 0.000007 | 0.000007 | Ok |
| 958 TANAH BATUAN | 0.00042 0.000194 | 4.734E-08 | 0.0024 | 0.0111 | 0.000007 | 0.000007 | 0.000007 | Ok |

Kombinasi Pembebatan

19 1,4D

4 1,2D + 1,6L + 0,5 (Br atau R)

3. 10 D + 1,6 (Br atau R) + (L atau 0,5W)

4. 1,2D + 1,0W + L + 0,5 (Br atau R)

5. 120 + 1,0E + L

a. 1,2D + 1,0E (Tanah batuan)+ L

b. 1,2D + 1,0E (Tanah keras) + L

Tabel 4 Twist Yang Terjadi Pada Jenis Tanah Keras

| TABLE: Joint Displacements | | | | | | | | | |
|----------------------------|-------------|---------|---------|-----------|--------|--------|----------|---------|--|
| Joint | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | Radians | Radians | Radians | degree | degree | degree | <0.5° | |
| 1 | TANAH KERAS | 0.00069 | 0.00027 | 7.13E-09 | 0.0040 | 0.0130 | 0.000004 | Ok | |
| 2 | TANAH KERAS | 0.00069 | 0.00027 | 7.13E-09 | 0.0040 | 0.0130 | 0.000004 | Ok | |
| 3 | TANAH KERAS | 0.00069 | 0.00027 | 2.348E-08 | 0.0040 | 0.0130 | 0.000013 | Ok | |
| 4 | TANAH KERAS | 0.00069 | 0.00027 | 2.348E-08 | 0.0040 | 0.0130 | 0.000013 | Ok | |
| 829 | TANAH KERAS | 0.00069 | 0.00027 | 5.434E-08 | 0.0040 | 0.0130 | 0.000031 | Ok | |
| 835 | TANAH KERAS | 0.00069 | 0.00027 | 5.434E-08 | 0.0040 | 0.0130 | 0.000031 | Ok | |
| 952 | TANAH KERAS | 0.00069 | 0.00027 | 5.434E-08 | 0.0040 | 0.0130 | 0.000031 | Ok | |
| 958 | TANAH KERAS | 0.00069 | 0.00027 | 5.434E-08 | 0.0040 | 0.0130 | 0.000031 | Ok | |

Tabel 5 Twist Yang Terjadi Pada Jenis Tanah Sedang

| TABLE: Joint Displacements | | | | | | | | | |
|----------------------------|--------------|---------|---------|-----------|--------|--------|----------|---------|--|
| Joint | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | Radians | Radians | Radians | degree | degree | degree | <0.5° | |
| 1 | TANAH SEDANG | 0.00076 | 0.00251 | 7.803E-09 | 0.0044 | 0.0144 | 0.000004 | Ok | |
| 2 | TANAH SEDANG | 0.00076 | 0.00251 | 7.803E-09 | 0.0044 | 0.0144 | 0.000004 | Ok | |
| 3 | TANAH SEDANG | 0.00076 | 0.00251 | 2.564E-08 | 0.0044 | 0.0144 | 0.000015 | Ok | |
| 4 | TANAH SEDANG | 0.00076 | 0.00251 | 2.564E-08 | 0.0044 | 0.0144 | 0.000015 | Ok | |
| 829 | TANAH SEDANG | 0.00076 | 0.00251 | 5.927E-08 | 0.0044 | 0.0144 | 0.000034 | Ok | |
| 835 | TANAH SEDANG | 0.00076 | 0.00251 | 5.927E-08 | 0.0044 | 0.0144 | 0.000034 | Ok | |
| 952 | TANAH SEDANG | 0.00076 | 0.00251 | 5.927E-08 | 0.0044 | 0.0144 | 0.000034 | Ok | |
| 958 | TANAH SEDANG | 0.00076 | 0.00251 | 5.927E-08 | 0.0044 | 0.0144 | 0.000034 | Ok | |

Tabel 6 Twist Yang Terjadi Pada Jenis Tanah Lunak

| TABLE: Joint Displacements | | | | | | | | | |
|----------------------------|-------------|---------|---------|-----------|--------|--------|----------|---------|--|
| Joint | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | Radians | Radians | Radians | degree | degree | degree | <0.5° | |
| 1 | TANAH LUNAK | 0.00008 | 0.00262 | 7.387E-09 | 0.0046 | 0.0150 | 0.000005 | Ok | |
| 2 | TANAH LUNAK | 0.00008 | 0.00262 | 7.387E-09 | 0.0046 | 0.0150 | 0.000005 | Ok | |
| 3 | TANAH LUNAK | 0.00008 | 0.00262 | 2.586E-08 | 0.0046 | 0.0150 | 0.000015 | Ok | |
| 4 | TANAH LUNAK | 0.00008 | 0.00262 | 2.586E-08 | 0.0046 | 0.0150 | 0.000015 | Ok | |
| 829 | TANAH LUNAK | 0.00008 | 0.00262 | 5.988E-08 | 0.0046 | 0.0150 | 0.000034 | Ok | |
| 835 | TANAH LUNAK | 0.00008 | 0.00262 | 5.988E-08 | 0.0046 | 0.0150 | 0.000034 | Ok | |
| 952 | TANAH LUNAK | 0.00008 | 0.00262 | 5.988E-08 | 0.0046 | 0.0150 | 0.000034 | Ok | |
| 958 | TANAH LUNAK | 0.00008 | 0.00262 | 5.988E-08 | 0.0046 | 0.0150 | 0.000034 | Ok | |

2. Hasil Analisa Sway yang terjadi pada tower



Gambar 11 Sway Yang Terjadi Pada Tower

Tabel 7 Sway Yang Terjadi Pada Jenis Tanah Batu

| TABLE: Joint Velocities - Absolute | | | | | | | | | |
|------------------------------------|--------------|---------|---------|------------|------------|------------|------------|---------|--|
| 4 | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | rad/sec | rad/sec | rad/sec | degree/sec | degree/sec | degree/sec | <0.5° | |
| 1 | TANAH BATUAN | 0.00068 | 0.03072 | 2.772E-07 | 0.04 | 0.18 | 0.00 | Ok | |
| 2 | TANAH BATUAN | 0.00068 | 0.03072 | 2.772E-07 | 0.04 | 0.18 | 0.00 | Ok | |
| 3 | TANAH BATUAN | 0.00068 | 0.03072 | 0.00001275 | 0.04 | 0.18 | 0.00 | Ok | |
| 4 | TANAH BATUAN | 0.00068 | 0.03072 | 0.00001275 | 0.04 | 0.18 | 0.00 | Ok | |
| 829 | TANAH BATUAN | 0.00067 | 0.03082 | 0.0000277 | 0.04 | 0.18 | 0.00 | Ok | |
| 835 | TANAH BATUAN | 0.00067 | 0.03082 | 0.0000277 | 0.04 | 0.18 | 0.00 | Ok | |
| 952 | TANAH BATUAN | 0.00067 | 0.03082 | 0.0000277 | 0.04 | 0.18 | 0.00 | Ok | |
| 958 | TANAH BATUAN | 0.00067 | 0.03082 | 0.0000277 | 0.04 | 0.18 | 0.00 | Ok | |

Tabel 8 Sway Yang Terjadi Pada Jenis Tanah Keras

| TABLE: Joint Velocities - Absolute | | | | | | | | | |
|------------------------------------|-------------|---------|---------|------------|------------|------------|------------|---------|--|
| 4 | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | rad/sec | rad/sec | rad/sec | degree/sec | degree/sec | degree/sec | <0.5° | |
| 1 | TANAH KERAS | 0.00169 | 0.09513 | 3.928E-07 | 0.06 | 0.20 | 0.00 | Ok | |
| 2 | TANAH KERAS | 0.00169 | 0.09513 | 3.928E-07 | 0.06 | 0.20 | 0.00 | Ok | |
| 3 | TANAH KERAS | 0.00169 | 0.09513 | 0.00001293 | 0.06 | 0.20 | 0.00 | Ok | |
| 4 | TANAH KERAS | 0.00169 | 0.09513 | 0.00001293 | 0.06 | 0.20 | 0.00 | Ok | |
| 829 | TANAH KERAS | 0.00172 | 0.09523 | 0.00002862 | 0.06 | 0.20 | 0.00 | Ok | |
| 835 | TANAH KERAS | 0.00172 | 0.09523 | 0.00002862 | 0.06 | 0.20 | 0.00 | Ok | |
| 952 | TANAH KERAS | 0.00172 | 0.09523 | 0.00002862 | 0.06 | 0.20 | 0.00 | Ok | |
| 958 | TANAH KERAS | 0.00172 | 0.09523 | 0.00002862 | 0.06 | 0.20 | 0.00 | Ok | |

Tabel 9 Sway Yang Terjadi Pada Jenis Tanah Sedang

| TABLE: Joint Velocities - Absolute | | | | | | | | | |
|------------------------------------|--------------|---------|---------|------------|------------|------------|------------|---------|--|
| 4 | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | rad/sec | rad/sec | rad/sec | degree/sec | degree/sec | degree/sec | <0.5° | |
| 1 | TANAH SEDANG | 0.00175 | 0.09862 | 4.219E-07 | 0.07 | 0.22 | 0.00 | Ok | |
| 2 | TANAH SEDANG | 0.00175 | 0.09862 | 4.219E-07 | 0.07 | 0.22 | 0.00 | Ok | |
| 3 | TANAH SEDANG | 0.00175 | 0.09861 | 0.00001385 | 0.07 | 0.22 | 0.00 | Ok | |
| 4 | TANAH SEDANG | 0.00175 | 0.09861 | 0.00001385 | 0.07 | 0.22 | 0.00 | Ok | |
| 829 | TANAH SEDANG | 0.00179 | 0.09872 | 0.00003074 | 0.07 | 0.22 | 0.00 | Ok | |
| 835 | TANAH SEDANG | 0.00179 | 0.09872 | 0.00003074 | 0.07 | 0.22 | 0.00 | Ok | |
| 952 | TANAH SEDANG | 0.00179 | 0.09872 | 0.00003074 | 0.07 | 0.22 | 0.00 | Ok | |
| 958 | TANAH SEDANG | 0.00179 | 0.09872 | 0.00003074 | 0.07 | 0.22 | 0.00 | Ok | |

Tabel 10 Sway Yang Terjadi Pada Jenis Tanah Lunak

| TABLE: Joint Velocities - Absolute | | | | | | | | | |
|------------------------------------|-------------|---------|---------|------------|------------|------------|------------|---------|--|
| 4 | OutputCase | R1 | R2 | R3 | R1 | R2 | R3 | Kontrol | |
| Text | Text | rad/sec | rad/sec | rad/sec | degree/sec | degree/sec | degree/sec | <0.5° | |
| 1 | TANAH LUNAK | 0.00126 | 0.09952 | 3.914E-07 | 0.07 | 0.23 | 0.00 | Ok | |
| 2 | TANAH LUNAK | 0.00126 | 0.09952 | 3.914E-07 | 0.07 | 0.23 | 0.00 | Ok | |
| 3 | TANAH LUNAK | 0.00126 | 0.09951 | 0.00001285 | 0.07 | 0.23 | 0.00 | Ok | |
| 4 | TANAH LUNAK | 0.00126 | 0.09951 | 0.00001285 | 0.07 | 0.23 | 0.00 | Ok | |
| 829 | TANAH LUNAK | 0.00129 | 0.09972 | 0.00002948 | 0.07 | 0.23 | 0.00 | Ok | |
| 835 | TANAH LUNAK | 0.00129 | 0.09972 | 0.00002948 | 0.07 | 0.23 | 0.00 | Ok | |
| 952 | TANAH LUNAK | 0.00129 | 0.09972 | 0.00002948 | 0.07 | 0.23 | 0.00 | Ok | |
| 958 | TANAH LUNAK | 0.00129 | 0.09972 | 0.00002948 | 0.07 | 0.23 | 0.00 | Ok | |

3. Hasil analisa displacement yang terjadi pada tower



Gambar 12 Displacement Yang Terjadi Pada Tower

Tabel 11 Displacement Yang Terjadi Pada Jenis Tanah Batuan

| Joint | OutputCase | CaseType | StepType | U1 | U2 | U3 | Kontrol |
|-------|--------------|-----------------|----------|----------|----------|----------|---------|
| Text | Text | Text | Text | mm | mm | mm | H/200 |
| 1 | TANAH BATUAN | LinRespSpec Max | | 3.919099 | 0.851969 | 0.145126 | OK |
| 2 | TANAH BATUAN | LinRespSpec Max | | 3.919099 | 0.851969 | 0.145126 | OK |
| 3 | TANAH BATUAN | LinRespSpec Max | | 3.919058 | 0.851978 | 0.031549 | OK |
| 4 | TANAH BATUAN | LinRespSpec Max | | 3.919058 | 0.851978 | 0.031549 | OK |
| 829 | TANAH BATUAN | LinRespSpec Max | | 3.91903 | 0.851963 | 0.148499 | OK |
| 835 | TANAH BATUAN | LinRespSpec Max | | 3.91903 | 0.851963 | 0.148499 | OK |
| 952 | TANAH BATUAN | LinRespSpec Max | | 3.91903 | 0.851963 | 0.148499 | OK |
| 958 | TANAH BATUAN | LinRespSpec Max | | 3.91903 | 0.851963 | 0.148499 | OK |

Tabel 12 Displacement Yang Terjadi Pada Jenis Tanah Keras

| Joint | OutputCase | CaseType | StepType | U1 | U2 | U3 | Kontrol |
|-------|-------------|-----------------|----------|----------|----------|----------|---------|
| Text | Text | Text | Text | mm | mm | mm | H/200 |
| 1 | TANAH KERAS | LinRespSpec Max | | 4.601747 | 1.400517 | 0.170215 | OK |
| 2 | TANAH KERAS | LinRespSpec Max | | 4.601747 | 1.400517 | 0.170215 | OK |
| 3 | TANAH KERAS | LinRespSpec Max | | 4.601698 | 1.400532 | 0.051805 | OK |
| 4 | TANAH KERAS | LinRespSpec Max | | 4.601698 | 1.400532 | 0.051805 | OK |
| 829 | TANAH KERAS | LinRespSpec Max | | 4.601666 | 1.400507 | 0.177905 | OK |
| 835 | TANAH KERAS | LinRespSpec Max | | 4.601666 | 1.400507 | 0.177905 | OK |
| 952 | TANAH KERAS | LinRespSpec Max | | 4.601666 | 1.400507 | 0.177905 | OK |
| 958 | TANAH KERAS | LinRespSpec Max | | 4.601666 | 1.400507 | 0.177905 | OK |

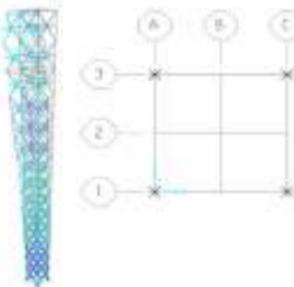
Tabel 13 Displacement Yang Terjadi Pada Jenis Tanah Sedang

| TABLE: Joint Displacements | | | | | | | |
|----------------------------|--------------|-----------------|----------|----------|----------|----------|---------|
| Joint | OutputCase | CaseType | StepType | U1 | U2 | U3 | Kontrol |
| Text | Text | Text | Text | mm | mm | mm | H/200 |
| 1 | TANAH SEDANG | LinRespSpec Max | | 5.083739 | 1.547209 | 0.188005 | OK |
| 2 | TANAH SEDANG | LinRespSpec Max | | 5.083739 | 1.547209 | 0.188005 | OK |
| 3 | TANAH SEDANG | LinRespSpec Max | | 5.083686 | 1.547225 | 0.057219 | OK |
| 4 | TANAH SEDANG | LinRespSpec Max | | 5.083686 | 1.547225 | 0.057219 | OK |
| 829 | TANAH SEDANG | LinRespSpec Max | | 5.08365 | 1.547198 | 0.196499 | OK |
| 835 | TANAH SEDANG | LinRespSpec Max | | 5.08365 | 1.547198 | 0.196499 | OK |
| 952 | TANAH SEDANG | LinRespSpec Max | | 5.08365 | 1.547198 | 0.196499 | OK |
| 958 | TANAH SEDANG | LinRespSpec Max | | 5.08365 | 1.547198 | 0.196499 | OK |

Tabel 14 Displacement Yang Terjadi Pada Jenis Tanah Lunak

| TABLE: Joint Displacements | | | | | | | |
|----------------------------|-------------|-----------------|----------|----------|----------|----------|---------|
| Joint | OutputCase | CaseType | StepType | U1 | U2 | U3 | Kontrol |
| Text | Text | Text | Text | mm | mm | mm | H/200 |
| 1 | TANAH LUNAK | LinRespSpec Max | | 5.311284 | 1.616461 | 0.196277 | OK |
| 2 | TANAH LUNAK | LinRespSpec Max | | 5.311284 | 1.616461 | 0.196277 | OK |
| 3 | TANAH LUNAK | LinRespSpec Max | | 5.311228 | 1.616478 | 0.059737 | OK |
| 4 | TANAH LUNAK | LinRespSpec Max | | 5.311228 | 1.616478 | 0.059737 | OK |
| 829 | TANAH LUNAK | LinRespSpec Max | | 5.311191 | 1.61645 | 0.205145 | OK |
| 835 | TANAH LUNAK | LinRespSpec Max | | 5.311191 | 1.61645 | 0.205145 | OK |
| 952 | TANAH LUNAK | LinRespSpec Max | | 5.311191 | 1.61645 | 0.205145 | OK |
| 958 | TANAH LUNAK | LinRespSpec Max | | 5.311191 | 1.61645 | 0.205145 | OK |

4. Hasil analisa Joint Reaction Pada Tower



Gambar 13 Titik Joint Reaction Pada Tower

Tabel 15 Nilai Joint Reaction Pada Jenis Tanah Batuan

| TABLE: Joint Reactions | | | | | | | |
|------------------------|--------------|----------|----------|-----------|-------------|------------|-----------|
| Joint | OutputCase | F1 | F2 | F3 | M1 | M2 | M3 |
| Text | Text | N | N | N | N-mm | N-mm | N-mm |
| 762 | TANAH BATUAN | 25537.18 | 38141.21 | 525264.61 | 23333974.22 | 1010170012 | 2585403.7 |
| 765 | TANAH BATUAN | 25537.18 | 38141.21 | 525264.61 | 23333974.31 | 1010170011 | 2585403.7 |
| 885 | TANAH BATUAN | 25537.18 | 38141.21 | 525264.61 | 23333974.24 | 1010170012 | 2585403.7 |
| 888 | TANAH BATUAN | 25537.18 | 38141.21 | 525264.61 | 23333974.28 | 1010170011 | 2585403.7 |

Tabel 16 Nilai Joint Reaction Pada Jenis Tanah

2eras

TABLE: Joint Reactions

| Table 1: Joint Reactions | | | | | | |
|--------------------------|--------------|----------|----------|----------|-------------|-------------|
| Joint | Output Case | F1 | F2 | F3 | M1 | M2 |
| Text | Text | N | N | N | N-mm | N-mm |
| 762 | TANA H KERAS | 30754.63 | 45050.37 | 628425.3 | 37066191.18 | 117961974.6 |
| 765 | TANA H KERAS | 30754.63 | 45050.37 | 628425.3 | 37066191.26 | 117961974.6 |
| 885 | TANA H KERAS | 30754.63 | 45050.37 | 628425.3 | 37066191.2 | 117961974.7 |
| 888 | TANA H KERAS | 30754.63 | 45050.37 | 628425.3 | 37066191.23 | 117961974.6 |

Tabel 17 Nilai Joint Reaction Pada Jenis Tanah

2 dang

TABLE: Joint Reactions

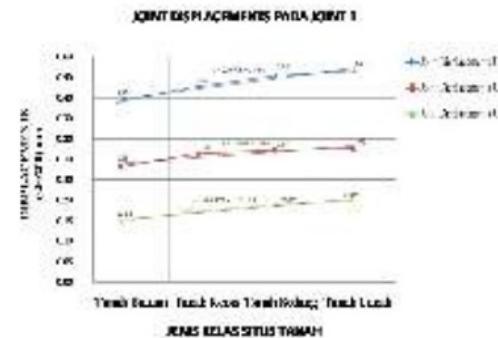
| Welded Joint Properties | | | | | | |
|-------------------------|--------------|----------|----------|-----------|------------|-------------|
| Joint | OutputCase | F1 | F2 | F3 | M1 | M2 |
| Text | Text | N | N | N | N-mm | N-mm |
| 762 | TANAH SEDANG | 33835.36 | 49740 | 693927.07 | 4090740.95 | 130180313.5 |
| 765 | TANAH SEDANG | 33835.36 | 49740.01 | 693927.07 | 4090740.64 | 130180313.4 |
| 885 | TANAH SEDANG | 33835.36 | 49740 | 693927.07 | 4090740.57 | 130180313.5 |
| 888 | TANAH SEDANG | 33835.36 | 49740.01 | 693927.07 | 4090740.61 | 130180313.4 |

Tabel 18 Nilai Joint Reaction Pada Jenis Tanah

2 unak

TABLE: Joint Reactions

| Joint | OutputCase | F1 | F2 | F3 | M1 | M2 | M3 |
|-------|-------------|----------|----------|-----------|-------------|-------------|----------|
| Text | Text | N | N | N | N-mm | N-mm | N-mm |
| 762 | TANAH LUNAK | 34823.87 | 51858.75 | 723798.83 | 42585646.27 | 135497841.3 | 3526036. |
| 765 | TANAH LUNAK | 34823.87 | 51858.75 | 723798.83 | 42585646.37 | 135497841.2 | 3526036. |
| 885 | TANAH LUNAK | 34823.87 | 51858.75 | 723798.83 | 42585646.3 | 135497841.3 | 3526036. |
| 888 | TANAH LUNAK | 34823.87 | 51858.75 | 723798.83 | 42585646.34 | 135497841.2 | 3526036. |



Gambar 15 Grafik Hubungan Jenis Tanah Dan Displacement

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4. KESIMPULAN

Dari hasil analisa di atas didapat kesimpulan sebagai berikut:

1. Pengaruh beban gempa terhadap nilai *Twist*, *Sway*, dan *Displacement* yang terjadi pada struktur tower BTS tidak melebihi syarat yang ditentukan dimana nilai *Twist* dan *Sway* tidak melebihi **0.5°** dan untuk nilai *Displacement* tidak melebihi **H/200 (30000/200 = 150 mm)**.
 2. Pengaruh beban gempa dengan beberapa situs kelas tanah yang berupa tanah batuan, tanah keras, tanah sedang dan tanah lunak didapat nilai twist & sway sebagai berikut :
 - a. Semakin lunak kondisi tanah maka terjadi peningkatan nilai *Twist* pada struktur tower dimana nilai *Twist* tertinggi terjadi pada jenis tanah lunak pada arah Y sebesar 0.015° .
 - b. Semakin lunak kondisi tanah maka terjadi peningkatan nilai *Sway* pada struktur tower dimana nilai *Sway* tertinggi terjadi pada jenis tanah lunak pada arah Y sebesar 0.227° .
 3. Pengaruh *Displacement* yang terjadi akibat beban gempa dimana :
 - a. Pada arah x terjadi peningkatan nilai *Displacement* dari jenis tanah batuan ke jenis tanah lunak dimana nilai *Displacement* tertinggi terjadi pada

- jenis tanah lunak sebesar $5.31\text{mm} < H/200(30000/200=150 \text{ mm})$.
- b. Pada arah y terjadi peningkatan nilai *Displacement* dari jenis tanah batuan ke jenis tanah lunak dimana nilai *Displacement* tertinggi terjadi pada jenis tanah lunak sebesar $1.62 \text{ mm} < H/200(30000/200=150 \text{ mm})$.
 - c. Pada arah z terjadi peningkatan nilai *Displacement* dari jenis tanah batuan ke jenis tanah lunak dimana nilai *Displacement* tertinggi terjadi pada jenis tanah lunak sebesar $0.20 \text{ mm} < H/200 (30000/200 = 150 \text{ mm})$.
4. Hasil dari perhitungan pengaruh beban gempa terhadap nilai twist, sway (point 2) maupun displacement (point 3) yang terjadi pada struktur tower BTS masih dibawah/tidak melebihi syarat nilai yang ditentukan. Nilai puntiran, goyangan maupun perpindahan yang diakibatkan beban gempa tersebut dengan kondisional berbagai jenis tanah dikabupaten jember, masih **AMAN dimana** gaya - gaya yang ditimbulkan tidak berpengaruh pada struktur Tower BTS maupun antena yang terpasang.

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