SESMIC ANALYSIS OF ROOFTOP MOUNTED TELECOMMUNICATION TOWER

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Abstract - Due to the boom in the telecommunication business, number of buildings carrying a roof top tower has been increased rapidly. Most of the building were not originally designed to carry a roof top tower, but later converted to carry roof top towers due to the changed requirements. In the present work an attempt has been made to study the behavior of buildings with roof top tower in the event of an Earth Quake using STAAD pro. A typical commercial building is considered for the analysis. Four towers with height 15m and 30m is considered for the study.In this Paper We have presented the results of (G+5) commercial buildings of various plot area with telecommunication tower mounted on its rooftop.

Key Words: Commercial Building, Telecommunication Tower, Staad Pro.

I. INTRODUCTION

The Indian telecom service business is the fastest growing one in the world, with over seven million mobile subscribers being added every month. This expanding base possesses challenges to mobile operators in terms of augmenting and upgrading infrastructure to maintain to quality of services. A rapidly increasing subscriber base and a more stringent spectrum allocating regime may create a higher requirement of tower sites for operators to accommodate more subscribers. Hence it became a costly and tedious task to identify sufficient land for construction of towers. This led to the extensive use of the roof top of multistoried buildings for installing communication towers. However many of these buildings were not designed to take care of tower load, particularly under earthquake Conditions.

II. SELECTION OF BUILDING

The floor area, the number of floors and the shape of the building on which the roof top tower is installed varies from building to building. Based on the survey of the buildings where roof top towers were installed, it has been found that most of the towers are installed on commercial buildings and their structural dimensions vary within arrange. Hence a typical commercial building frame with along span and shorts pan floor structure has been considered for the analysis. Figure shows the graphical representation of the Building.

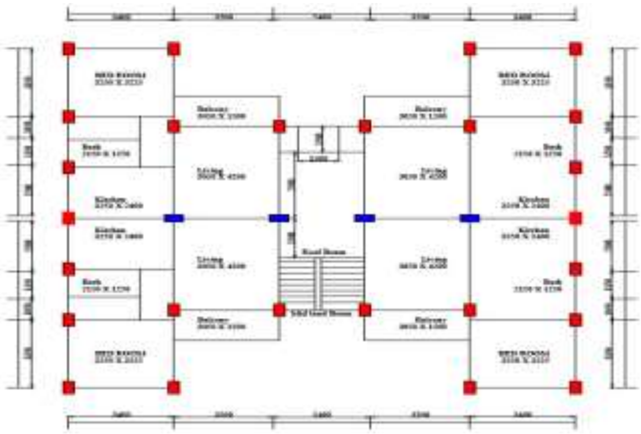

Fig -1: Layout Plan

III. PLAN AND SPECIFICATION

A. Building Specification

Table -1

Type of building	Commercial Building
Height of the building	21m
Number of stories	(G+5)
Floor-to-Floor height	3m
Materials	M28 for beams M30 for columns Fe-415 for steel
Column size	600mm × 360mm
Beam size	360mm × 300mm
Depth of Slab	150mm

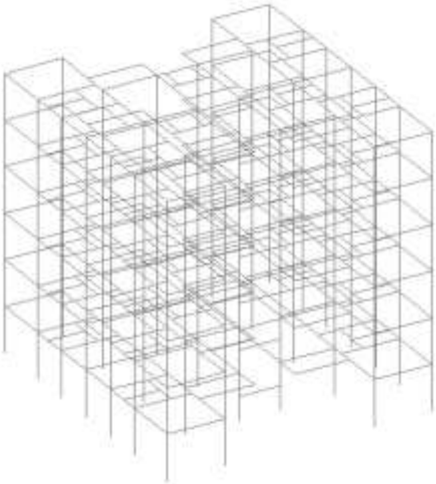

Fig -2: Building Model

B. Tower Specification

In general, height of rooftop tower ranges from 9m to 30m in order to have wide range, tower with height 21m Considered for analysis. This tower is four legged steel lattice tower with cross bracings. Tower tower considered for present study is shown in figure

Table -2

Height of tower	15m and 20m
Location	Centrally side located on rooftop
Beams	Rectangular-section

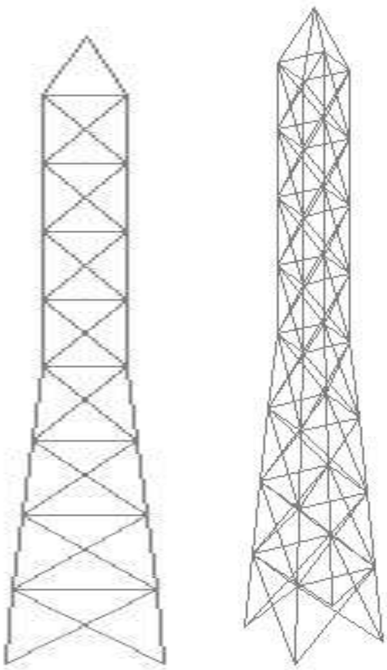

Fig -3: 21m Tower

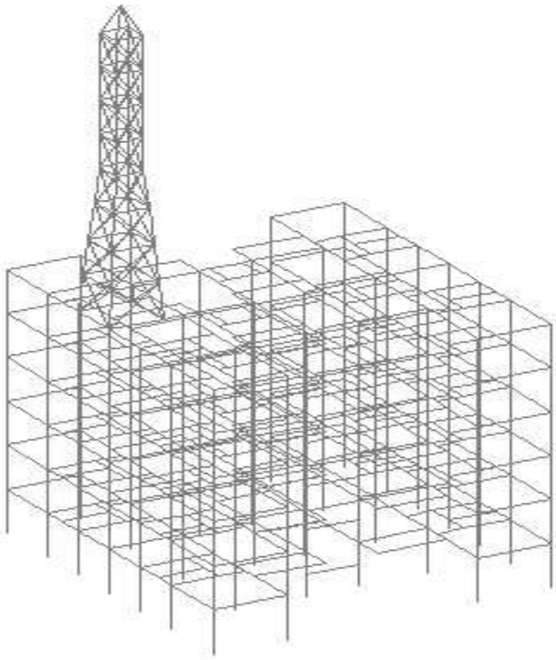

Fig -4: Building with Tower

IV. TOWER LOACATION

For these analyses is of buildings with towers on roof top, bureau of Indian standards recommends to lump the mass of towers on roof top. However it is not clear whether this approach will be giving the correct assessment on the building behavior for tall towers. So it has been proposed to carry out seismic analysis of the building in two ways. 1. By lumping the tower mass at roof level 2. By considering the full tower.

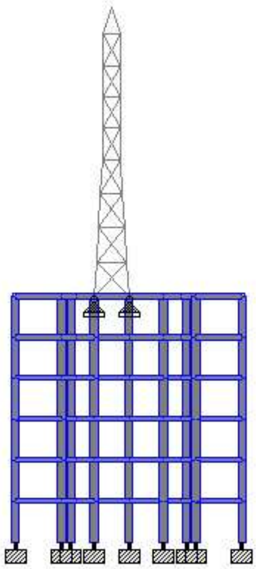

Fig -5: Assigning property

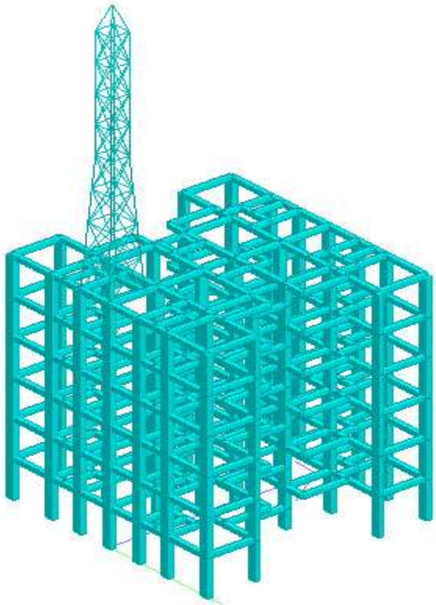

Fig -6: Render view Of Model

V. LOAD AND LOAD COMBINATION

Gravity loads include dead loads and live loads. The dead loads include the permanent loads of the structure and equipment and other fixtures that are not likely to vary during the service life of the structure. Live loads include the variable loads due to occupants and appliances.

Wind load and seismic load calculation is done as per provisions given in Indian Standard Specification (IS: 875 (Part 3) –1987 (Reaffirmed 2003), IS1893 (Part 1): 2002) Wind load is calculated by the basic wind speed of the area and is modified to include geometric, topographic and functional parameters. For Seismic load calculation, the building is considered to be located in zone three of the four zones in India.

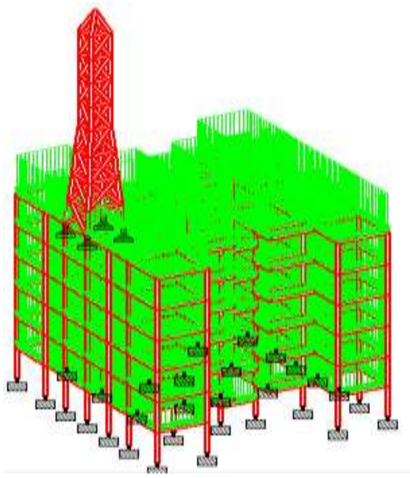

Fig -7: Load condition

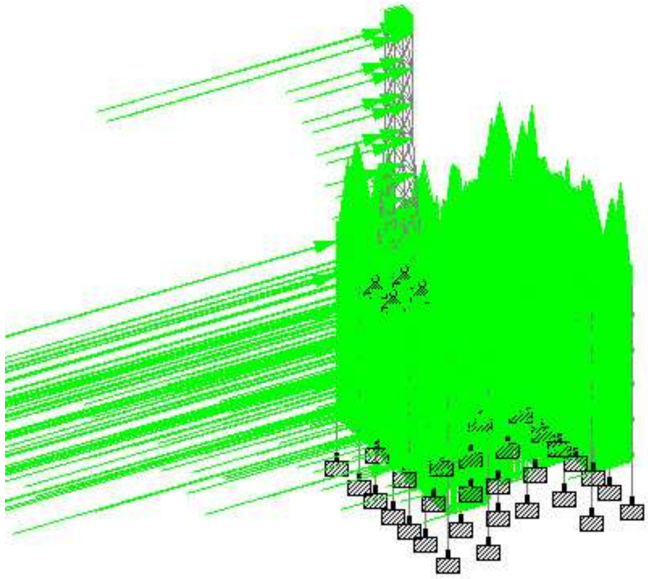

Fig -8: Load Combination

VI. RCC DESIGN

```
STAAD SPACE                                              -- PAGE NO.   17

=========================================================================
                B E A M  N O.     9  D E S I G N  R E S U L T S

      M28                    Fe415 (Main)              Fe415 (Sec.)

   LENGTH:  2150.0 mm      SIZE:   300.0 mm X  360.0 mm   COVER: 25.0 mm

                      DESIGN LOAD SUMMARY (KN MET)
-------------------------------------------------------------------------
SECTION |FLEXURE  (Maxm. Sagging/Hogging moments)|          SHEAR
(in mm) |     P        MZ         MX   Load Case |   VY       MX  Load Case
-------------------------------------------------------------------------
    0.0 |    0.00     12.93      0.25      1     |  57.64     2.23      7
        |    0.00    -49.79      1.48     13     |
  179.2 |    0.00     11.88      0.25      1     |  54.98     2.23      7
        |    0.00    -40.44      1.48     13     |
  358.3 |    0.00     10.83      0.25      1     |  51.78     2.23      7
        |    0.00    -31.50      1.48     13     |
  537.5 |    0.00      9.77      0.25      1     |  47.68     2.23      7
        |    0.00    -23.05      1.48     13     |
  716.7 |    0.00      9.67      1.54      8     |  44.54     2.23      7
        |    0.00    -16.50      0.79      9     |
  895.8 |    0.00     11.99      1.54      8     |  40.01     2.23      7
        |    0.00    -11.01      0.79      9     |
 1075.0 |    0.00     14.54      2.09     12     |  35.09     2.23      7
        |    0.00     -5.93      0.79      9     |
 1254.2 |    0.00     17.90      2.09     12     |  29.78     2.23      7
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Fig -9: Design Load Summary

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SUMMARY OF REINF. AREA (Sq.mm)

------------------------------------------------------------------------------
SECTION |          TOP           |        BOTTOM          |  STIRRUPS
(in mm) | Reqd./Provided reinf.  | Reqd./Provided reinf.  |  (2 legged)
------------------------------------------------------------------------------
   0.0 | 467.65/ 471.24( 6-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
 179.2 | 377.51/ 392.70( 5-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
 358.3 | 293.84/ 314.16( 4-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
 537.5 | 216.86/ 235.62( 3-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
 716.7 | 202.77/ 235.62( 3-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
 895.8 | 202.77/ 235.62( 3-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
1075.0 | 202.77/ 235.62( 3-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
1254.2 | 202.77/ 235.62( 3-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
1433.3 | 202.77/ 235.62( 3-10í )| 202.77/ 235.62( 3-10í )|  8í  @ 140 mm
1612.5 | 202.77/ 235.62( 3-10í )| 223.58/ 235.62( 3-10í )|  8í  @ 140 mm
1791.7 | 202.77/ 235.62( 3-10í )| 249.34/ 314.16( 4-10í )|  8í  @ 140 mm
1970.8 | 202.77/ 235.62( 3-10í )| 266.62/ 314.16( 4-10í )|  8í  @ 140 mm
2150.0 | 202.77/ 235.62( 3-10í )| 275.93/ 314.16( 4-10í )|  8í  @ 140 mm
------------------------------------------------------------------------------
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Fig -10: Reinf. Area

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DESIGN FORCES (KNS-MET)
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DESIGN AXIAL FORCE (Pu)              :    -16.13

                                         About Z        About Y
INITIAL MOMENTS                      :    18.08           1.91
MOMENTS DUE TO MINIMUM ECC.          :     0.32           0.42

SLENDERNESS RATIOS                   :    -              -
MOMENTS DUE TO SLENDERNESS EFFECT    :    -              -
MOMENT REDUCTION FACTORS             :    -              -
ADDITION MOMENTS (Maz and May)       :    -              -

TOTAL DESIGN MOMENTS                 :    18.08           1.91

REQD. STEEL AREA    :     1728.00 Sq.mm.
REQD. CONCRETE AREA:   214272.02 Sq.mm.
MAIN REINFORCEMENT : Provide  16 - 12 dia. (0.84%,   1809.56 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. rectangular ties @ 190 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :   3430.51   Muz1 :      89.74   Muy1 :     158.68
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Fig -11: Design Forces

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STAAD SPACE                                   -- PAGE NO.  872

    **************  CONCRETE  TAKE OFF  **************
         (FOR BEAMS, COLUMNS AND PLATES DESIGNED ABOVE)
NOTE: CONCRETE QUANTITY REPRESENTS VOLUME OF CONCRETE IN BEAMS, COLUMNS, AND PLATES DESIGNED ABOVE.
      REINFORCING STEEL QUANTITY REPRESENTS REINFORCING STEEL IN BEAMS AND COLUMNS DESIGNED ABOVE.
      REINFORCING STEEL IN PLATES IS NOT INCLUDED IN THE REPORTED QUANTITY.

    TOTAL VOLUME OF CONCRETE =      246.0 CU.METER

               BAR DIA       WEIGHT
               (in mm)       (in New)
               -------       -------
                  8            54518
                 10            18804
                 12           111710
                 16             5531
                 20             4575
                            ----------
               *** TOTAL=     194608

460. PARAMETER 2
461. CODE INDIAN
462. CHECK CODE MEMB 810 TO 921
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Fig -12: Concrete Take off

VII. STEEL DESIGN

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MEMBER     TABLE        RESULT/   CRITICAL COND/     RATIO/     LOADING/
                          FX           MY              MZ       LOCATION
=========================================================================

 810 ST   L25203                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.778          3
                       15.18 C      -0.04           -0.03         0.75
 811 ST   L25203                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.804         11
                       15.20 C       0.04           -0.04         0.75
 812 ST   L25203                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.778          9
                       15.19 C       0.04           -0.03         0.75
 813 ST   L25203                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.804         10
                       15.20 C      -0.04           -0.04         0.75
 814 ST   L40354                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.911          9
                       39.73 C      -0.06           -0.04         3.01
 815 ST   L40354                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.913          3
                       39.73 C       0.06           -0.04         3.01
 816 ST   L40354                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.913          3
                       39.73 C      -0.06           -0.04         3.01
 817 ST   L40354                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.911          9
                       39.73 C       0.06           -0.04         3.01
 818 ST   L40404                  (AISC SECTIONS)
                         PASS    IS-7.1.1(A)         0.998          9
```

Fig -13: Steel Design

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STEEL TAKE-OFF
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   PROFILE              LENGTH(METE)      WEIGHT(KN   )

ST  L40355                   4.50             0.502
ST  L40405                   1.50             0.179
ST  L20202                 169.19             4.059
ST  L25253                  28.47             1.277
ST  L30304                   4.42             0.315
ST  L20203                  31.30             1.112
ST  L25203                  21.40             0.860
ST  L35305                   1.50             0.144
ST  L30305                   0.75             0.066
ST  L40354                   0.75             0.067
ST  L35354                   3.00             0.251
ST  L30254                   3.00             0.195
ST  L30303                   1.50             0.081
ST  L30253                   1.50             0.074
                                      ----------------
                             TOTAL =          9.182
```

Fig -14: Steel Take off

VII. CONCLUSIONS

It is been observed that the loads on RCC structure are not nominal and cannot be withstand by the existing member and need proper design check of the RCC structural member before installation of telecommunication tower on the existing structure.

Installing of a tower at roof top makes a building vulnerable to earthquake, as it calls for additional requirement of steel in both columns and beams

Considering the importance of the additional external loads due to telecommunication tower on a building structure, it is been concluded that the design of the columns get effected tremendously hence the telecommunication tower should not be installed on the building which are not designed for such loads.

There is a reduction in the total steel requirement in both columns and beams, if tower is placed in the short span of the building.

Further, rooftop towers cannot be based on analytical results obtained for a similar configuration situated at ground level, since the member forces in the tower mounted on rooftop are more than the member forces of tower installed at ground level.

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