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Comparative Performance Assessment of Diagrid, Outrigger, And Twisted Frame Structural System as Per Indian Standards

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Abstract - *The increasing urbanization and erection of tall buildings requires the new structural systems which can effectively resist the lateral loads as the conventional frames undergo the undue displacement. This paper discusses the comparison of three innovative systems of lateral resisting systems Outrigger, Diagrid and Twisted Frame structures. Three identical buildings are modeled and analyzed under dead, live and wind loads according to Indian standard codes using STAAD. Pro Software. Using different critical parameters i.e., maximum displacement, storey drift and internal forces this study identifies efficiency, stability and distribution of lateral loads among the three systems. These observations help the engineers to design better and economic tall buildings with less material.*

Key Words: (Outrigger structure, Diagrid structure, Twisted frame structure).

1. INTRODUCTION:

Rapid urbanization and limited land availability in India have increased the demand for high-rise buildings. As building height increases, the effect of lateral forces, particularly wind loads, becomes significant and can influence structural stability, displacement, and occupant comfort. Therefore, the selection of an efficient structural system is essential for ensuring the safety and performance of tall buildings. Among the various structural systems used in modern high-rise construction, the Outrigger system, Diagrid system, and Twisted building configuration are widely recognized for their ability to resist lateral loads. Theoretical background of structural systems:

1.1 Outrigger structural system:

The outrigger system improves the lateral stiffness of tall buildings by connecting a central core to exterior columns through horizontal outriggers, thereby reducing overturning effects under lateral loads.

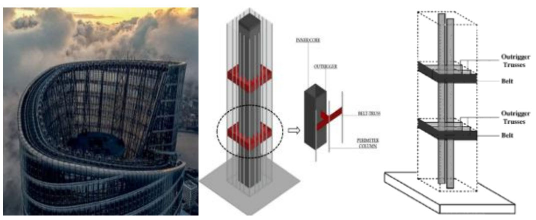


Fig -1.1: Outrigger structural system

1.2 Diagrid Structural System:

The diagrid structural system consists of a network of diagonal members arranged along the building perimeter, forming triangular patterns. Unlike conventional framed structures, vertical perimeter columns are eliminated or minimized. The diagonal members primarily resist lateral loads through axial forces rather than bending.

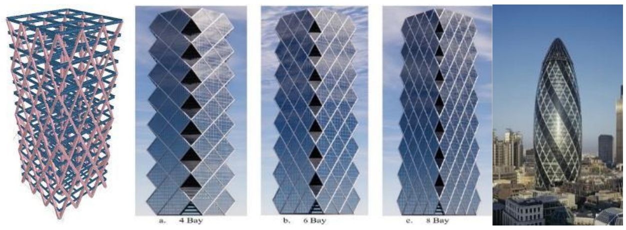


Fig -1.2: Diagrid structural system

1.3 Twisted Structural Configuration:

The twisted structural configuration is a geometric modification in which each floor plate rotates by a certain angle relative to the floor below. This progressive rotation alters the aerodynamic profile of the building and reduces wind vortex shedding effects. From a structural perspective, twisting influences load distribution and stiffness characteristics.

Fig -1.3: Twisted structural system

1.4 Objectives of the Study:

- To evaluate the structural performance of conventional, diagrid, outrigger, and twisted tall building systems under lateral loads.

• To model and analyze these structural systems under wind and seismic loading as per Indian Standards.
• To compare key structural parameters such as storey displacement, storey drift, and base shear.
• To identify the most efficient and economical structural system for high-rise buildings.

1.5 Scope of the Study:

This study focuses on analyzing and comparing different structural systems used in high-rise buildings to understand their behavior under lateral loads. The research includes the modeling of conventional, diagrid, outrigger, and twisted building configurations and evaluating their performance under wind and seismic forces as per Indian Standard codes.

2. LITERATURE REVIEW:

1. Khushbu Jani et al. (2013) Title: Analysis and Design of Diagrid Structural System for High Rise Steel Buildings
Comment: The study concluded that the Diagrid system efficiently resists wind-induced lateral loads through axial action of inclined perimeter members, resulting in reduced displacement and improved structural stability in tall buildings.
2. Yenal Takva et al. (2023) Title: Effect of Outrigger System in High-Rise Buildings on Structural Behavior and Cost
Comment: The research demonstrated that the Outrigger system significantly enhances lateral stiffness, reduces storey displacement and drift, and provides an economical solution for wind-resistant high-rise structures.

3. METHODOLOGY:

Table -3.1: Dimension and types of structure

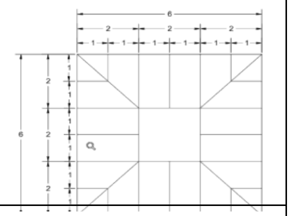
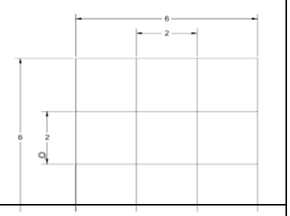
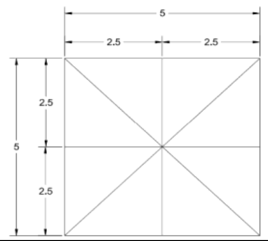
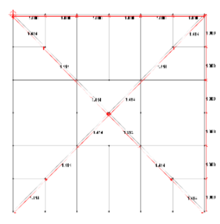
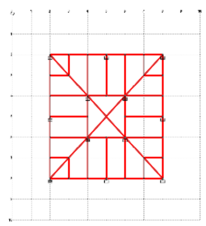
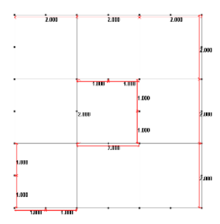
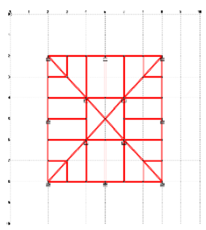
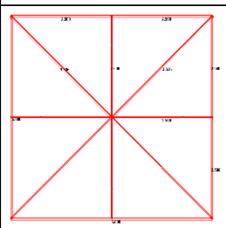
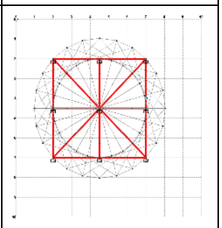
Types Of Structure	Dimensions
Outrigger structural system	
Diagrid Structural System	
Twisted Structural System	

Table -3.2: Staad pro and revit model

Name	Node distance	Grid pattern
Outrigger structure		
Diagrid structure		
Twisted structure		

3.1 Flow chart:

The structural models of diagrid, outrigger and twisted frame were prepared.

⇩

3d Modeling of buildings in Revit software.

⇩

Importing and analyzing models in STAAD.Pro.

⇩

Assignment of material properties, supports and member sections.

⇩

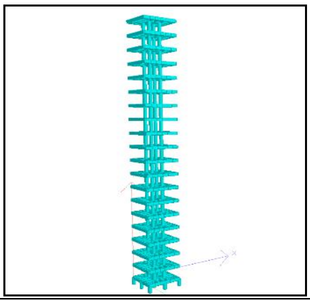
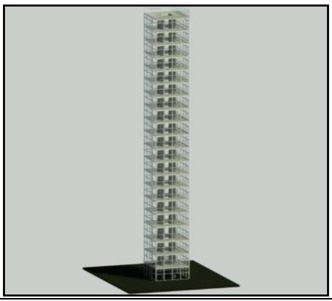
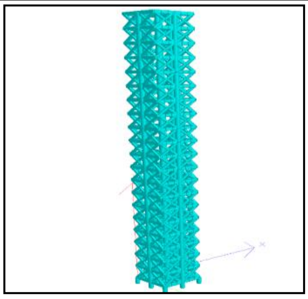
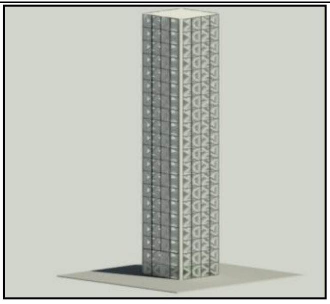
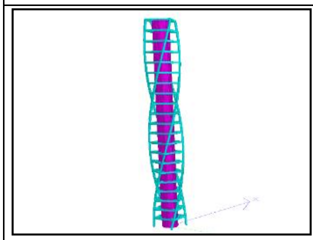
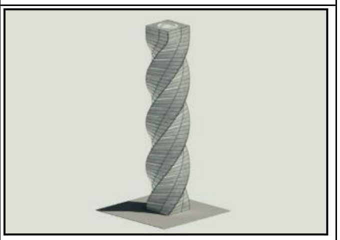
Application of dead, live and wind loads according to IS codes.

⇩

Comparing to determine the most efficient Structural system structural system.

Fig -3.1: Flow chart

Table -3.3: Staad pro and revit model

Staad Pro Model	Revit Model
	
	
	

3.2 Material Selection:

- Concrete Grade: M25 grade concrete with characteristic compressive strength (fck) of 25 MPa is adopted for all structural members in accordance with Indian Standard provisions.
- Reinforcement Steel: Fe500 grade high-yield strength deformed bars with yield strength (fy) of 500 MPa are used as primary reinforcement to ensure adequate structural strength and ductility.
- Structural Steel: Fe250 grade steel with yield strength of 250 MPa is considered for structural steel components and secondary elements in the analytical model.
- Loading Conditions: Dead loads, live loads, and wind loads are considered in the analysis as per relevant Indian Standard codes to evaluate the structural performance under various loading conditions.

3.1 Load:

Table -3.4: Dead load, live load and wind load

Dead load (IS: 875 part 1:1987)	
Self-Weight	FACTOR = 1
Floor finish	Pressure = 1.5 kN/m^2
Uniform Force on Floors	W1 = 10 kN/m^2
Uniform Force on Roof	W2 = 1 kN/m^2
Live load (IS: 875:part 2-1987)	
Floor Load	Pressure = 3 kN/m^2
Wind load (IS: 875:part 3:2015)	
Wind pressure	P_Z= 1206.91 N/m^2

3.2 Wind parameter:

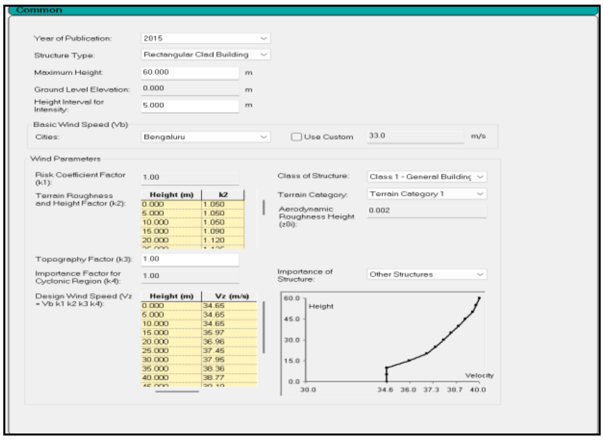


Fig -3.2: Wind Parameter (IS:875 PART 3:2015)

3.3 Load combination:

Table -3.5: Load combination

L/C	Type	Name
1	Primary	DL
2	Primary	LL
4	Primary	WL+X
5	Primary	WL-X
6	Primary	WL+Z
7	Primary	WL-Z
8	Combination	COMB - 1.5 Dead + 1.5 Live
9	Combination	COMB - 1.2 Dead + 1.2 Live + 1.2 Wind (1)
10	Combination	COMB - 1.2 Dead + 1.2 Live + 1.2 Wind (2)
11	Combination	COMB - 1.2 Dead + 1.2 Live + 1.2 Wind (3)
12	Combination	COMB - 1.2 Dead + 1.2 Live + 1.2 Wind (4)
13	Combination	COMB - 1.2 Dead + 1.2 Live + -1.2 Wind (1)
14	Combination	COMB - 1.2 Dead + 1.2 Live + -1.2 Wind (2)
15	Combination	COMB - 1.2 Dead + 1.2 Live + -1.2 Wind (3)
16	Combination	COMB - 1.2 Dead + 1.2 Live + -1.2 Wind (4)
17	Combination	COMB - 1.2 Dead + 1.2 Live
18	Combination	COMB - 1.5 Dead + 1.5 Wind (1)
19	Combination	COMB - 1.5 Dead + 1.5 Wind (2)
20	Combination	COMB - 1.5 Dead + 1.5 Wind (3)
21	Combination	COMB - 1.5 Dead + 1.5 Wind (4)
22	Combination	COMB - 1.5 Dead + -1.5 Wind (1)
23	Combination	COMB - 1.5 Dead + -1.5 Wind (2)
24	Combination	COMB - 1.5 Dead + -1.5 Wind (3)
25	Combination	COMB - 1.5 Dead + -1.5 Wind (4)
26	Combination	COMB - 1.5 Dead
27	Combination	COMB - 0.9 Dead + 1.5 Wind (1)
28	Combination	COMB - 0.9 Dead + 1.5 Wind (2)
29	Combination	COMB - 0.9 Dead + 1.5 Wind (3)
30	Combination	COMB - 0.9 Dead + 1.5 Wind (4)
31	Combination	COMB - 0.9 Dead + -1.5 Wind (1)
32	Combination	COMB - 0.9 Dead + -1.5 Wind (2)
33	Combination	COMB - 0.9 Dead + -1.5 Wind (3)
34	Combination	COMB - 0.9 Dead + -1.5 Wind (4)
35	Combination	COMB - 0.9 Dead

4. RESULTS AND DISCUSSIONS:

4.1 Outrigger Structure:

The STAAD.Pro concrete take-off report indicates that Structure 1 requires a total concrete volume of **380.1 m³** and a reinforcement steel quantity of **175,532 N**. The structure shows moderate material consumption, with reinforcement primarily consisting of 8 mm and 10 mm diameter bars. The results indicate efficient utilization of materials while maintaining the required structural strength and stability.

```
************** 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 =      380.1 CU.METER

        BAR DIA       WEIGHT
        (in mm)       (in New)
        --------      --------
           8           57044
          10           77999
          12           25677
          16            7410
          20            7402
                   ------------
        *** TOTAL=     175532

1178. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAR 12,2026   TIME= 13:15:26 ****
```

Fig -4.1: outrigger structure

4.2 Diagrid Structure:

Structure 2 requires a total concrete volume of **583.0 m³** and a reinforcement steel quantity of **258,946 N.** This is the highest material requirement among the three structural systems. The increased concrete and steel consumption indicates higher stiffness and load-carrying capacity; however, it also results in greater self-weight and construction cost.

```
************** 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 =      583.0 CU.METER

        BAR DIA       WEIGHT
        (in mm)       (in New)
        --------      --------
           8           94124
          10           67058
          12           90541
          16            6208
          20            1016
                   ------------
        *** TOTAL=     258946

1448. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAR 12,2026   TIME= 13:39:43 ****
```

Fig -4.2: Diagrid structure

4.3 Twisted Structure:

The concrete take-off report for Structure 3 shows a total concrete volume of **377.0 m^3** and a reinforcement steel quantity of **109,183 N.** This structure requires the least amount of concrete and steel compared to the other models. The lower material consumption demonstrates better structural efficiency and economical design, making it the most material-efficient system among the three structures analyze.

```
************** 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 =      377.0 CU.METER

          BAR DIA       WEIGHT
          (in mm)       (in New)
          --------      --------
             8           35124
            10           51219
            12           10294
            16            7185
            20            4136
            25            1224
                      ------------
     *** TOTAL=         109183

4930. FINISH

*********** END OF THE STAAD.Pro RUN ***********

**** DATE= MAR 12,2026   TIME= 13:49:36 ****
```

Fig -4.3: Twisted frame structure

4.4 Wind intensity structure:

Table -4.1: Wind intensity

Height	Outrigger structure	Diagrid structure	Twisted frame structure
(m)	(kN/m2)	(kN/m2)	(kN/m2)
0	1.461	1.461	0.72
5	1.461	1.461	0.72
10	1.461	1.461	0.72
15	1.575	1.575	0.776
20	1.663	1.663	0.82
25	1.707	1.707	0.842
30	1.753	1.753	0.864
35	1.791	1.791	0.883
40	1.83	1.83	0.902
45	1.869	1.869	0.921
50	1.909	1.909	0.941
55	1.928	1.928	0.95
60	1.935	1.947	0.96

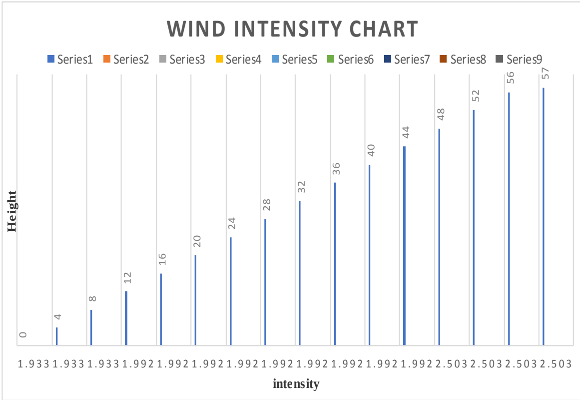


Fig -4.4: Wind intensity chart

The table shows that the Outrigger and Diagrid structures have similar wind intensity, while the Twisted structure exhibits lower wind intensity, making it more economical.

4.5 Outrigger Structure Result:

```
IS-456   L I M I T   S T A T E   D E S I G N
B E A M  N O.    1  D E S I G N  R E S U L T S

M25                  Fe500 (Main)            Fe500 (Sec.)

LENGTH:  1000.0 mm    SIZE:  300.0 mm X  600.0 mm   COVER: 30.0 mm

            SUMMARY OF REINF. AREA (Sq.mm)
----------------------------------------------------------------------
SECTION     0.0 mm      250.0 mm     500.0 mm     750.0 mm     1000.0 mm
----------------------------------------------------------------------
 TOP        288.15      288.15       288.15       288.15       288.15
REINF.    (Sq. mm)    (Sq. mm)     (Sq. mm)     (Sq. mm)     (Sq. mm)

BOTTOM      288.15      288.15       288.15       288.15       288.15
REINF.    (Sq. mm)    (Sq. mm)     (Sq. mm)     (Sq. mm)     (Sq. mm)
----------------------------------------------------------------------

            SUMMARY OF PROVIDED REINF. AREA
----------------------------------------------------------------------
SECTION     0.0 mm      250.0 mm     500.0 mm     750.0 mm     1000.0 mm
----------------------------------------------------------------------
 TOP        4-10d       4-10d        4-10d        4-10d        4-10d
REINF.   1 layer(s)  1 layer(s)   1 layer(s)   1 layer(s)   1 layer(s)

BOTTOM      4-10d       4-10d        4-10d        4-10d        4-10d
REINF.   1 layer(s)  1 layer(s)   1 layer(s)   1 layer(s)   1 layer(s)

SHEAR   2 legged  8d 2 legged  8d 2 legged  8d 2 legged  8d 2 legged  8d
REINF.  @ 195 mm c/c @ 195 mm c/c @ 195 mm c/c @ 195 mm c/c @ 195 mm c/c
```

Fig -4.5: Beam design

```
IS-456   L I M I T   S T A T E   D E S I G N
C O L U M N  N O.   66  D E S I G N  R E S U L T S

M25                  Fe500 (Main)              Fe500 (Sec.)

LENGTH:  3000.0 mm   CROSS SECTION:  600.0 mm dia.  COVER: 40.0 mm

** GUIDING LOAD CASE:    1 END JOINT:    13  TENSION COLUMN

REQD. STEEL AREA   :     4685.87 Sq.mm.
REQD. CONCRETE AREA:   278057.47 Sq.mm.
MAIN REINFORCEMENT : Provide  15 - 20 dia. (1.67%,    4712.39 Sq.mm.)
                     (Equally distributed)
TIE REINFORCEMENT  : Provide  8 mm dia. circular ties @ 300 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)
----------------------------------------------------------
Puz :   4885.35   Muz1 :     145.07   Muy1 :     145.07

INTERACTION RATIO: 0.95 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:     1
END JOINT:    38 Puz :    2049.89   Muz :        0.00   Muy :        0.00   IR: 0.70
```

Fig -4.6: Column design

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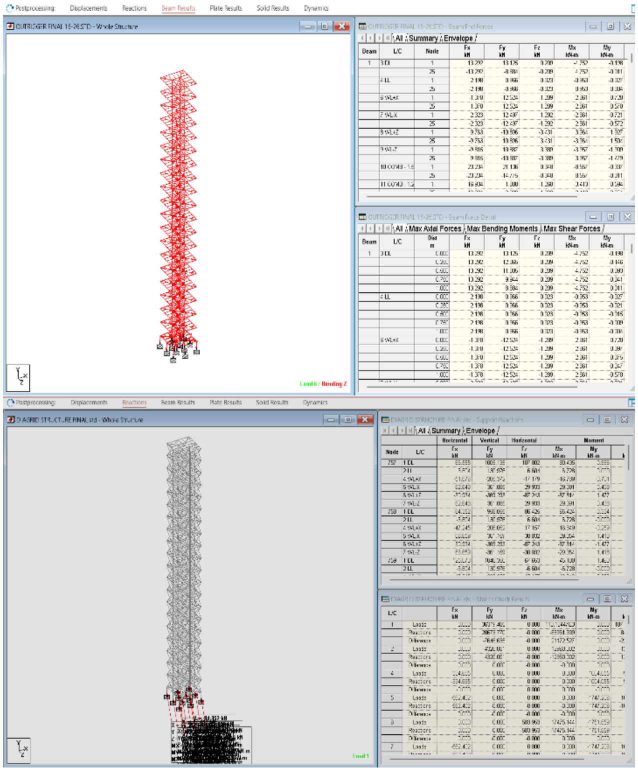

Fig -4.7: Reaction and Beam Result

4.6 Diagrid Structure Result:

```
==========================================================================
             IS-456   L I M I T   S T A T E   D E S I G N
         C O L U M N  N O.    9 D E S I G N  R E S U L T S

     M25                    Fe500 (Main)              Fe500 (Sec.)

LENGTH:  1414.2 mm   CROSS SECTION:  300.0 mm X  300.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    9 END JOINT:     1  TENSION COLUMN


REQD. STEEL AREA   :      263.83 Sq.mm.
REQD. CONCRETE AREA:    32978.48 Sq.mm.
MAIN REINFORCEMENT : Provide   4 - 12 dia. (0.50%,    452.39 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 :   1108.47   Muz1 :      6.16   Muy1 :      6.16

INTERACTION RATIO: 0.90 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:     1
END JOINT:     1 Puz :   1177.06   Muz :     26.04   Muy :     26.04   IR: 0.09
```

Fig -4.8: Beam design

```
==========================================================================
             IS-456   L I M I T   S T A T E   D E S I G N
         C O L U M N  N O.    9 D E S I G N  R E S U L T S

     M25                    Fe500 (Main)              Fe500 (Sec.)

LENGTH:  1414.2 mm   CROSS SECTION:  300.0 mm X  300.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    9 END JOINT:     1  TENSION COLUMN


REQD. STEEL AREA   :      263.83 Sq.mm.
REQD. CONCRETE AREA:    32978.48 Sq.mm.
MAIN REINFORCEMENT : Provide   4 - 12 dia. (0.50%,    452.39 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 :   1108.47   Muz1 :      6.16   Muy1 :      6.16

INTERACTION RATIO: 0.90 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
WORST LOAD CASE:     1
END JOINT:     1 Puz :   1177.06   Muz :     26.04   Muy :     26.04   IR: 0.09
```

Fig -4.9: Column design

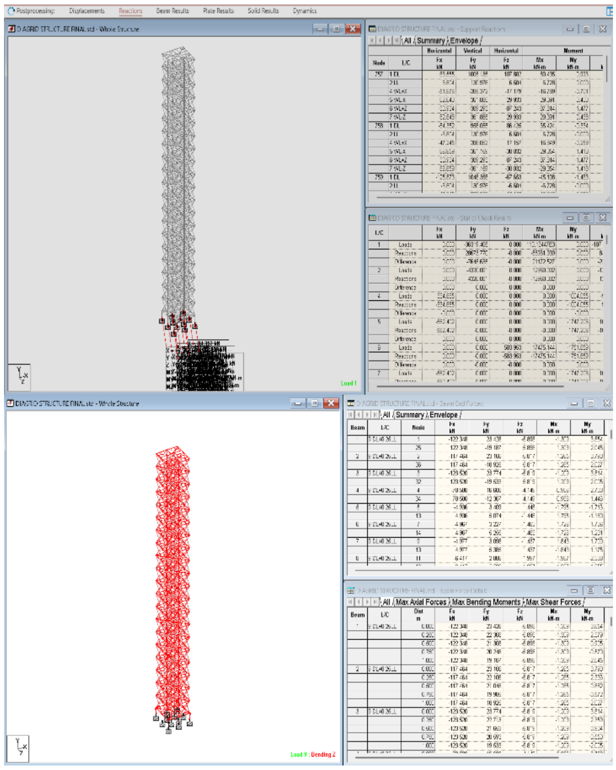

Fig -4.10: Reaction and beam result

4.7 Twisted frame Structure Steel Design:

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==========================================================================
              IS-456   L I M I T   S T A T E   D E S I G N
              B E A M  N O.   171  D E S I G N  R E S U L T S

   M25                   Fe500 (Main)               Fe500 (Sec.)

  LENGTH:  2500.0 mm     SIZE:   300.0 mm X  600.0 mm   COVER: 30.0 mm


                   SUMMARY OF REINF. AREA (Sq.mm)
--------------------------------------------------------------------------
SECTION      0.0 mm      625.0 mm     1250.0 mm    1875.0 mm    2500.0 mm
--------------------------------------------------------------------------
 TOP         288.15        0.00         0.00         0.00        288.15
REINF.     (Sq. mm)     (Sq. mm)     (Sq. mm)     (Sq. mm)     (Sq. mm)

BOTTOM       288.15      288.15       288.15       288.15        288.15
REINF.     (Sq. mm)     (Sq. mm)     (Sq. mm)     (Sq. mm)     (Sq. mm)
--------------------------------------------------------------------------


                   SUMMARY OF PROVIDED REINF. AREA
--------------------------------------------------------------------------
SECTION      0.0 mm      625.0 mm     1250.0 mm    1875.0 mm    2500.0 mm
--------------------------------------------------------------------------
 TOP        4-10d        4-10d        4-10d        4-10d        4-10d
REINF.   1 layer(s)   1 layer(s)   1 layer(s)   1 layer(s)   1 layer(s)

BOTTOM      4-10d        4-10d        4-10d        4-10d        4-10d
REINF.   1 layer(s)   1 layer(s)   1 layer(s)   1 layer(s)   1 layer(s)

SHEAR   2 legged  8d 2 legged  8d 2 legged  8d 2 legged  8d 2 legged  8d
REINF.  @ 195 mm c/c @ 195 mm c/c @ 195 mm c/c @ 195 mm c/c @ 195 mm c/c
--------------------------------------------------------------------------
```

Fig -4.11: Beam design

```
           IS-456   L I M I T   S T A T E   D E S I G N
       C O L U M N  N O.  3343 D E S I G N  R E S U L T S

     M25                   Fe500 (Main)              Fe500 (Sec.)

LENGTH:  4047.2 mm   CROSS SECTION:  300.0 mm X  300.0 mm  COVER: 40.0 mm

** GUIDING LOAD CASE:    9 BRACED LONG COLUMN


REQD. STEEL AREA   :      392.27 Sq.mm.
REQD. CONCRETE AREA:    49033.73 Sq.mm.
MAIN REINFORCEMENT : Provide   4 - 12 dia. (0.50%,    452.39 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 :   1155.19   Muz1 :     45.52   Muy1 :     45.52

INTERACTION RATIO: 0.78 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)
----------------------------------------------------------
```

Fig -4.12: Column design

```
ELEMENT DESIGN SUMMARY
----------------------

ELEMENT    LONG. REINF     MOM-X /LOAD     TRANS. REINF     MOM-Y /LOAD
           (SQ.MM/ME)      (KN-M/M)        (SQ.MM/ME)       (KN-M/M)

  587 TOP :     216.         0.76 /    9        216.          0.61 /    2
      BOTT:    216.         -0.06 /    1       216.          -0.49 /    1

  588 TOP :     216.         1.27 /    9        216.          0.62 /    2
      BOTT:    216.         -0.50 /    1       216.          -0.57 /    1

  589 TOP :     216.         1.68 /    9        216.          0.61 /    2
      BOTT:    216.         -0.87 /    1       216.          -0.68 /    1
```

Fig -4.13: Column design

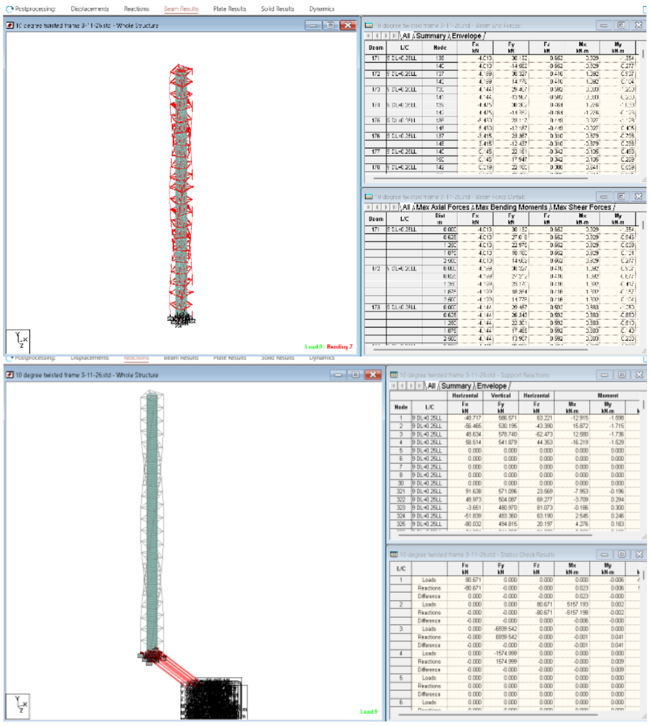

Fig -4.14: Reaction and beam result

5. VALIDATION OF MODELLING:

Table -5.1: Comparative Analysis of Structural Results:

Structure	Concrete Volume	Steel Quantity
Structure 1	380.1 m^3	175532 N
Structure 2	377.0 m^3	109183 N
Structure 3	583.0 m^3	258946 N

5.1 Justification:

The use of plate elements in structural analysis is widely accepted in industry practice for modelling slabs and shear-moment resisting components, ensuring accurate representation of stiffness and load distribution.

5.2 Comparative Discussion:

A comparison of material quantities from STAAD.Pro shows clear differences among the three structural systems.

1. **Structure 1** required a moderate amount of concrete and steel, providing a balanced structural solution.
2. **Structure 2** consumed the highest quantity of concrete and reinforcement steel, resulting in the greatest construction cost.
3. **Structure 3** required the least amount of concrete and steel, making it the most material-efficient and economical system.

Structure 3 requires the least amount of concrete and reinforcement, making it the most economical and material-efficient system among the three models. Reduced material usage lowers construction cost and dead load, improving seismic performance.

6. CONCLUSION:

1. The study compared Twisted Frame, Diagrid, and Outrigger systems for a G+20 building under wind loads.
2. Structural performance was evaluated using displacement, storey drift, stiffness, and material consumption.
3. The Diagrid system showed the highest stiffness and best material efficiency, while the Outrigger system provided effective drift control and stability.
4. The Twisted Frame system offered architectural advantages but required higher material usage and exhibited greater displacement.
5. Overall, the Diagrid and Outrigger systems proved more suitable for resisting wind loads in high-rise buildings.

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BIOGRAPHIES:

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