Linear Analysis of Reinforced Concrete Frame Multi F_ Level Symmetric and Asymmetric Buildings With or Without Shear Wall

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Abstract- **In this thesis a comparison of linear analysis of Reinforced Concrete Frame multi F_Level Symmetric and Asymmetric buildings with or without shear wall in seismic analysis and wind analysis is carried out. In this thesis comparison of seismic analysis linear static (equivalent static method) and wind analysis is done by using loads and load combinations. In this analysis the selection of building is a Reinforced Concrete Frame building, which is a multi F_Level building. In Indian region country divided four zones (II, III, IV and V) depending on seismic risk. In this thesis taking zone III, and SMRF (special moment resisting frame) building is using in this analysis. Moment resisting frame should resist both gravity and lateral loads and widely used for seismic resisting systems. Taking Rectangular, c-shape and L-shape of building with shear wall and without shear wall and comparing for F_Level drift, joint F_Level displacement, max and avg. F_Level drift, joint displacement and etc. by using 18 loads and load combinations for static analysis and wind analysis. For seismic analysis IS 1893(PART I):2002 and for wind analysis IS 875(PART I,II,III):1987 is using and the whole analysis is done with ETABS 2016 software programming.**

Index Terms- Symmetric, Asymmetric Building, Loads And Load Combinations, seismic analysis by ESM(Equivalent static method), wind analysis, Shear Wall, Linear Analysis, Joint Drift, F_Level Drift, Joint F_Level Displacement Maximum, E-Tabs 2016.

I. INTRODUCTION

A. General definitions:-

Structural analysis is a very crucial part of a design of buildings and other built benefits such as bridges and tunnels, as structural loads can cause stress, deformation and displacement that may result in structural problems or even failure.

Linear analysis: when the distortions of structures are linear combinations of applied loads, it is called linear. so, purpose of the linear analysis is to identify the evolution and inverse evolution between these two set of quantities. This evolution is called stiffness matrix of the structure.

Multi f_level building: Multi f_level building is generally designed for purpose to serve as a hospital, commercial mall or apartment. A midrise building has number of f_levels ranging from 4 to 12.Symmetric buildings are in square and rectangular in shape and Asymmetric building are l-shape, e-shape, c-shape, t-shape etc.

seismic analysis: the main specification of seismic analysis of structures are load carrying capacity, ductility, stiffness and damping and mass, is 1893-2002 is used to carry out seismic analysis of structures. The different analysis procedure is

1. Linear static analysis
2. Nonlinear static analysis.

Shear wall: Shear wall is a structural member used to resist lateral loads i.e. parallel to the plane of the wall, Shear wall resists the loads due to Cantilever Action. In other words, Shear walls are vertical elements of the horizontal forces resisting system. Shear walls are mostly important in high-rise buildings subject to lateral wind and seismic forces. Generally, shear walls are either plane or flanged in section, while core walls consist of channel sections. They also provide sufficient strength and stiffness to control lateral displacements. Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and reduces damage of structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Ideal location of shear walls: the ideal location of shear walls is as: Corners of the structure, Sides walls of the structure, Core or Centre of the building.

II. LITERATURE REVIEW

PotnuruAvinash (2017)studied analysis of G+15 multi-storied framed structure for different plan configuration i.e. Rectangular, I-shape, C-shape and L-shape building. The basic wind speed considered is 50m/s. For the analysis the software tool is used i.e. E-TABS. Different load combinations considered and compared the results of Lateral Displacement, Base shear, Over-turning moment, Torsion etc.., for all four Replicas. Result showed that after applying wind load the lateral displacements are going to increase according to its asymmetry. It was decreased by providing shear wall. F_Level displacement is drastically increasing from fourth to tenth F_Level. Percentage difference in torsion and base shear for all Replicas are very less. Moments in columns are going to change drastically. Maximum bending moment in beams is doubled for L-shape compare with rectangle plan configuration. 1.5(DL±WLX), 1.5(DL±WLY) load combinations creating maximum effect on all structural parameters. Over turning moment is very high for L-shape compare with the remaining configurations. SuruchiMishra(2017) studied the comparison of seismic behaviour of G+10 F_Level buildings having horizontal irregularity with the regular building of similar properties with and without shear wall by using ETAB software was done.For this purpose four multiF_Level building plans are considered that are symmetric plan, L shape, T shape, and + shape. For the comparison, parameters taken are lateral displacement, F_Level drift and Replica period. All the four buildings were analyzed for zone IV.10 F_Level building without shear wall square, L-shape, and +-shape are good on performance wise. And with shear wall +-shape, L-shape at corners, T-shape at corners.

III. MATHOD

SEISMIC ANALYSIS: Seismic forces are random in nature and unpredictable, the static and dynamic analysis of the construction have become the preliminary concern of civil engineers. use of analysis in research and practice has increased substantially in recent years due to the growth of verified and user-friendly software like (STADD PRO.and ETABS etc.) and the availability of fast software programming. The main parameters of the seismic analysis of structures are load carrying capacity, ductility, damping and stiffness. IS 1893-2002 is used to carry out the seismic analysis of multiF_LEVEL building. Static method is one of the most effective portions of seismic analysis.

Static Method: This method defines a sequence of forces acting on a building to represent the effect of seismic ground motion, mostly defined by a seismic design response spectrum method. It assumes that the building greets in its fundamental manner.it involves calculating the principal elastic manner of vibrations of structure. The relevancy of this method is extended in many building codes of seismic analysis and by applying factors to account for higher buildings with some higher modes, and for low levels of twisting and torsion. To account for effects due to "yielding" of the building structure, many codes apply for modification factors that decrease the design forces (e.g. force reduction factors).Since the Static Equivalent method is accurate and uncomplicated for short building especially for single F_Level building.

Wind Analysis: Wind has two aspects. The first is that its energy can be utilized to generate power, sail boats and cool down the temperature on a hot day. The other is that its loads any and every object that comes its way. The latter is the aspect an engineer is concerned with, since the load caused has to be sustained by a structure with the specified safety. All civil structures above ground have thus to be designed to resist wind loads. Wind flow generation is on account of atmospheric pressure differentials and manifests itself into various forms like monosonic wind, cyclones, typhoons, tornados, thunderstorms, localized storms etc.Wind analysis is a technique based on measure, correlate and predict (MCP) will be used for the longterm correction based on available long term wind datasets. A climate report summarizes the expected average wind conditions at the measurement point including analysis of turbulence, shear and other Measured meteorological parameters.Terminology is used in wind analysis: in wind analysis calculations some concepts and formulas are used as like basic wind speed, wind pressure, design wind speed and pressure, topography factor, zone, wind forces etc.

IV. METHODOLOGY

In this thesis work a comparative study of linear analysis of Reinforced Concrete Frame multi F_Level Symmetric and Asymmetric buildings with or without shear wall in seismic and wind analysis is carried out. In this thesis comparison of seismic analysis linear seismic (static) and wind analysis is done by using loads and load combinations using with and without shear walls. A comparison of results in terms of F_Level drift, F_Level displacement, F_Level drift etc. has been made. This analysis is done using simplified code method as per IS 1893 (PART I):2002 for seismic analysis and IS 875(PART I, II, III)-1987 for wind analysis.

A 10 F_Level (G+9) reinforced concrete buildings of different configuration in medium soil has a plan of rectangular shape, c-shape and L-shape, which is given as below and its height is 30.3m.

The different configurations of shear walls at corners, side of the building and core are arranged.

The grade of concrete is fck-25KN/mm2 and that of steel is Fe - 415.

The column size is of 0.70m x 0.50m , the beam size is 0.30m x 0.50m at inner side and 0.30m x 0.40m at outer side.

Unit weight of R.C.C: 25 KN/m3 as per table 1 (page 6), IS 875(PART 1):1987.

Modulus of elasticity for concrete, Ec: 5000√fck as per IS 456:2000.

Where fck= characteristic compressive strength of concrete.

Poison's ratio for concrete: 0.17

All the cases are assumed to have fixed support.

The analysis is done in ETABS 2016 software.

V. HELPFUL HINTS

A. Structural Data:

S.no.	Specifications	Details
1	Number of F_level	G+9 (10)
2	Ground F_LEVEL ht.	3.3 m
3	Floor to floor ht.	3 m
4	Floor thickness	150 mm
5	Shear Wall thickness	230 mm
6	Design philosophy	Limit state method conforming IS 456:2000
7	Analysis	Software programming calculated (E-TABS 2016)
8	Rebar	HYSD 415
9	Damping ratio	0.05
10	Importance factor	1
11	Response reduction factor	5
12	Zone factor	0.16
13	Wind zone	4
14	Windward coefficient	0.8
15	Leeward coefficient	0.5
16	Wind speed	47
17	Terrain category	3
18	Class structure	1
19	Risk coefficient(k_1)	1
20	Topography (k_3)	1
21	Dead load	2 KN/m^2
22	Live load	3 KN/m^2

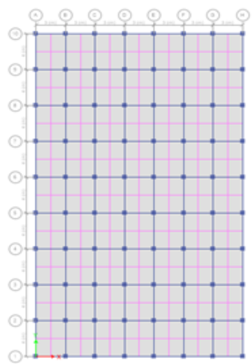
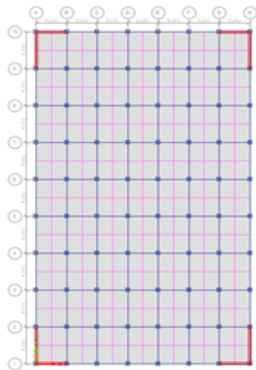
Table 1: geometric descriptions

All load combinations of 18 load combinations for earthquake (Equivalent static method) and wind analysis.

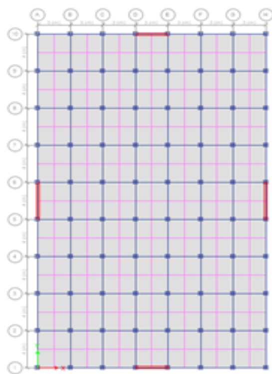
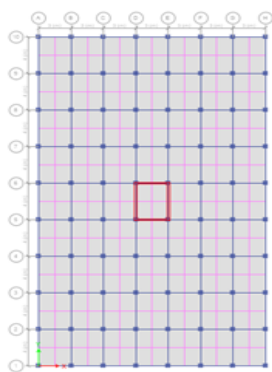
S.no.	Load combos for Earthquake	Load combos for Wind analysis
1	DL (DEAD LOAD)	DL (DEAD LOAD)
2	LL (LIVE LOAD)	LL (LIVE LOAD)
3	1.5 DL	1.5DL
4	EQ X (earthquake in X- direction)	W X (wind in X- direction)
5	EQ Y (earthquake in Y- direction)	W Y (wind in Y- direction)
6	1.5(DL+LL)	1.5(DL+LL)
7	0.9 DL+1.5 EQ X	0.9 DL+1.5 W X
8	0.9 DL+ 1.5 EQ Y	0.9 DL+ 1.5 W Y
9	0.9 DL-1.5 EQ X	0.9 DL-1.5 W X
10	0.9 DL- 1.5 EQ Y	0.9 DL- 1.5 W Y
11	1.2 (DL+LL + EQ X)	1.2 (DL+LL + W X)
12	1.2 (DL+LL- EQ X)	1.2 (DL+LL- W X)
13	1.2 (DL+LL+ EQ Y)	1.2 (DL+LL+ W Y)
14	1.2 (DL+LL- EQ Y)	1.2 (DL+LL- W Y)
15	1.5 (DL+ EQ X)	1.5 (DL+ W X)
16	1.5 (DL- EQ X)	1.5 (DL- W X)
17	1.5 (DL+ EQ Y)	1.5 (DL+ W Y)
18	1.5 (DL- EQ Y)	1.5 (DL- W Y)

Table 2: load and load combinations

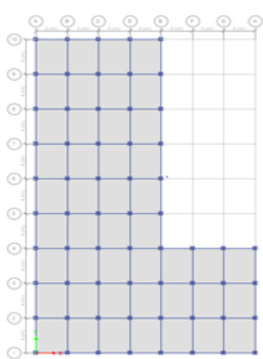
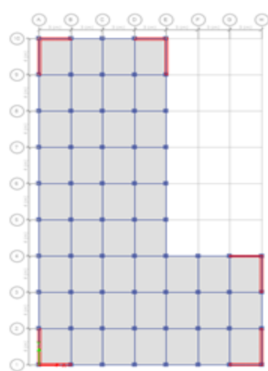
Structural Replicas As: structural replicas for different cases are as in figures

REPLICA STYLE A.1REPLICA STYLE A.2

REPLICA STYLE A.3 REPLICA STYLE A.4

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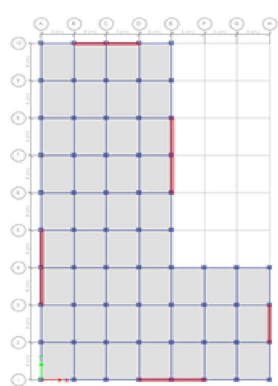
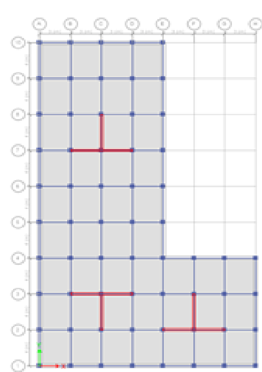
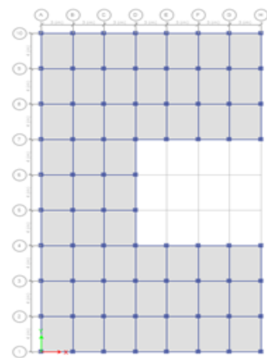
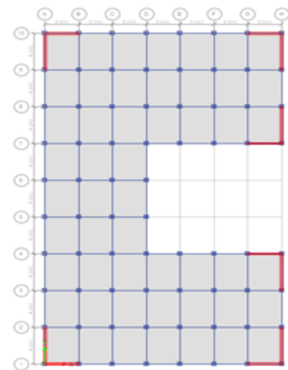



REPLICA STYLE B.3REPLICA STYLE B.4

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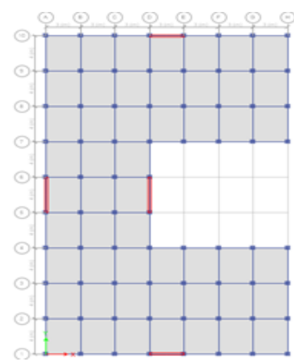
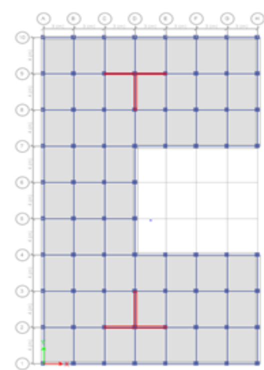



REPLICA STYLE C.3 REPLICA STYLE C.4

In all Replicas are made and analyzed. Following cases of building frames are considered-

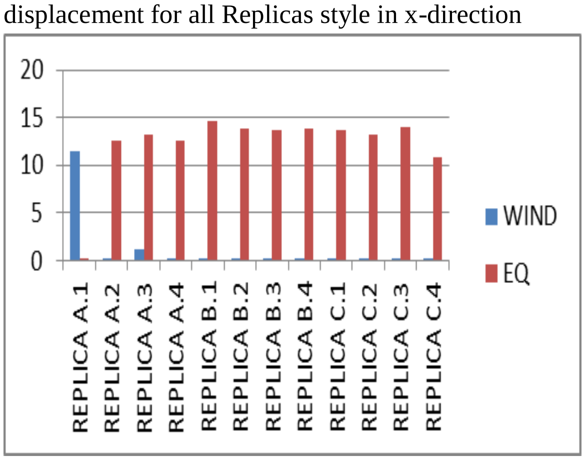
CASES	STRUCTURE	SHEAR WALL	ANALYSIS	METHOD
Case 1	Rectangular RC Frame	Without Shear Wall	Seismic	Linear ESM
Case 2	Rectangular RC Frame	Shear Wall At Corner	Seismic	Linear ESM
Case 3	Rectangular RC Frame	Shear Wall At Side	Seismic	Linear ESM
Case 4	Rectangular RC Frame	Shear Wall At Core	Seismic	Linear ESM
Case 5	Rectangular RC Frame	Without Shear Wall	Wind Analysis	Linear
Case 6	Rectangular RC Frame	Shear Wall At Corner	Wind Analysis	Linear
Case7	Rectangular RC Frame	Shear Wall At Side	Wind Analysis	Linear
Case8	Rectangular RC Frame	Shear Wall At Core	Wind Analysis	Linear
Case 9	C-Shape RC Frame	Without Shear Wall	Seismic	Linear ESM
Case 10	C-Shape RC Frame	Shear Wall At Corner	Seismic	Linear ESM
Case11	C-Shape RC Frame	Shear Wall At Side	Seismic	Linear ESM

Case 12	C-Shape RC Frame	Shear Wall At Core	Seismic	Linear ESM
Case13	C-Shape RC Frame	Without Shear Wall	Wind Analysis	Linear
Case 14	C-Shape RC Frame	Shear Wall At Corner	Wind Analysis	Linear
Case 15	C-Shape RC Frame	Shear Wall At Side	Wind Analysis	Linear
Case 16	C-Shape RC Frame	Shear Wall At Core	Wind Analysis	Linear
Case 17	L-Shape RC Frame	Without Shear Wall	Seismic	Linear ESM
Case 18	L-Shape RC Frame	Shear Wall At Corner	Seismic	Linear ESM
Case 19	L-Shape RC Frame	Shear Wall At Side	Seismic	Linear ESM
Case 20	L-Shape RC Frame	Shear Wall At Core	Seismic	Linear ESM
Case 21	L-Shape RC Frame	Without Shear Wall	Wind Analysis	Linear
Case 22	L-Shape RC Frame	Shear Wall At Corner	Wind Analysis	Linear
Case 23	L-Shape RC Frame	Shear Wall At Side	Wind Analysis	Linear
Case 24	L-Shape RC Frame	Shear Wall At Core	Wind Analysis	Linear

Table 3: all replica cases

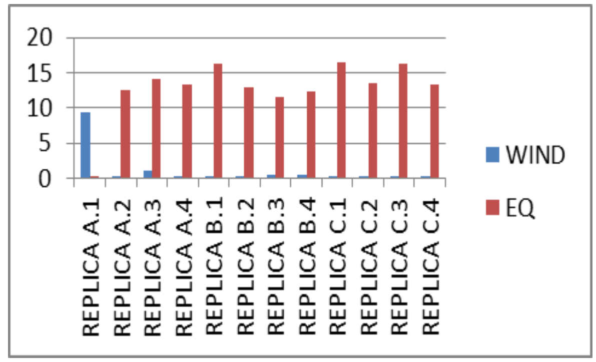
VI RESULT AND DISCUSSIONS

Comparison between EQ. and Wind analysis for joint displacement for all Replicas style in x-direction



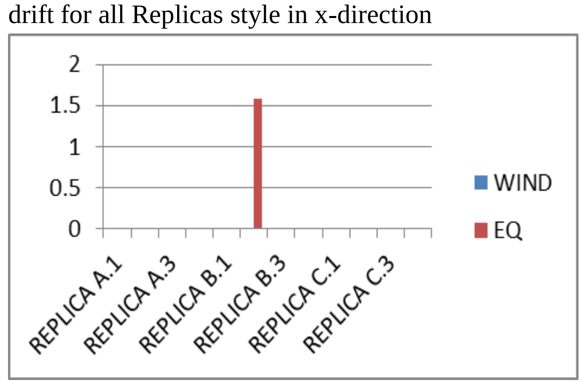
From the above graph comparison of REPLICAs are as under:-Maximum joint displacement is occurred in earthquake analysis maximum in Replica B.1 and minimum in Replica A.1.Maximum joint displacement is occurred in wind analysis for the same region is at Replica A.1 and minimum for Replica B.1.Hence, the minimum joint displacement for Earthquake is 0.036 and for wind analysis is 0.007.

Comparison between EQ. and Wind analysis for joint displacement for all Replicas style in y-direction



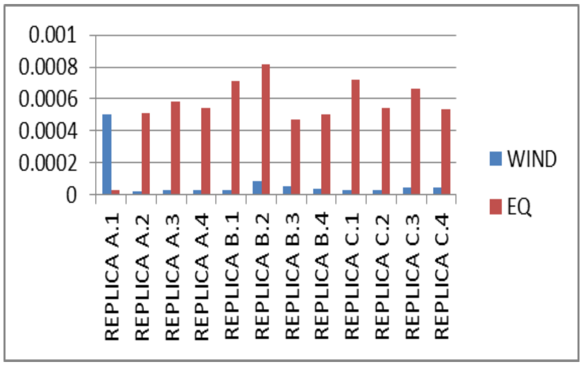
From the above graph comparison of REPLICAs are as under:-Maximum joint displacement is occurred in earthquake analysis maximum in Replica C.1 and minimum in Replica A.1.Maximum F_LEVEL displacement is occurred in wind analysis for the same region is at Replica A.1 and minimum for Replica B.1.Hence, the minimum F_LEVEL drift for Earthquake is 0.068 and for wind analysis is 0.064

Comparison between EQ. and Wind analysis for joint drift for all Replicas style in x-direction



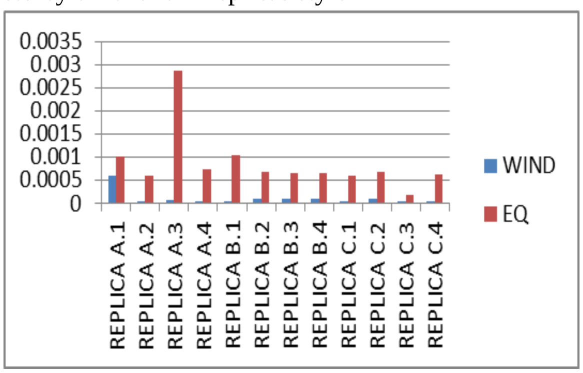
From the above graph and table comparison of REPLICAs are as under:-Maximum joint Drift is occurred in earthquake analysis maximum in Replica B.2 and minimum in Replica A.1.Maximum joint Drift is occurred in wind analysis for the same region is at Replica B.3 and minimum for Replica B.4.Hence, the minimum joint drift for Earthquake is 1.60E-05 and for wind analysis is 5.00E-06

Comparison between EQ. and Wind analysis for joint drift for all Replicas style in y-direction



From the above graph and table comparison of REPLICAs are as under:-Maximum joint Drift is occurred in earthquake analysis maximum in Replica B.2 and minimum in Replica A.1.Maximum joint Drift is occurred in wind analysis for the same region is at Replica A.1 and minimum for Replica A.2.Hence, the minimum joint drift for Earthquake is 0.000508 and for wind analysis is 0.000505.

Comparison between EQ. and Wind analysis for storey drift for all Replicas style



From the above graph and table comparison of REPLICAs are as under:-Maximum F_LEVEL Drift is occurred in earthquake analysis maximum in Replica A.3 and minimum in Replica C.3.Maximum F_LEVEL Drift is occurred in wind analysis for the same region is at Replica A.1 and minimum for Replica C.3.Hence, the minimum F_LEVEL drift for Earthquake is 2.60E-05 and for wind analysis is 0.000167.

VII. CONCLUSION

Here in this work Earthquake (Equivalent static method) and Wind analysis is analyzed with all the Replica cases of structure with and without shear wall. The conclusion of this work is as follows.

Sotrey drift:

F_LEVEL drift observed maximum value is seen in EQ. ESM and minimum in Wind analysis.The minimum value in chronological order of REPLICA style for ESM is REPLICA style C.1, style B.1, style C.3, style B.2, style C.2, style B.4, style B.3, style C.4, style A.4, style A.3, style A.2, style A.1 and for wind analysis is REPLICA style A.1, style C.2, style B.2, style B.3, style B.4, style A.3, style B.1, style C.1, style C.3, style C.4, style A.4, style A.2.

Joint Drift:Joint drift in x-direction observed maximum value is seen in EQ. ESM and minimum in wind analysis. Similarly Joint drift in y-direction observed maximum value is seen in EQ.ESM and minimum in wind analysis.The minimum value in x-direction chronological order of REPLICA style for ESM is REPLICA style B.2, style B.1, style C.1, style C.3, style C.2, style B.4, style A.3, style B.3, style A.4, style A.2, style C.4, style A.1 and for wind analysis is REPLICA style A.1, style C.2, style B.2, style B.3, style A.2, style C.1, style C.3, style B.1, style C.4, style A.3, style A.4, style B.4.The minimum value in y-direction chronological order of REPLICA style for ESM is REPLICA style B.1, style B.2, style C.1, style C.3, style A.3, style C.2, style A.4, style C.4, style A.2, style B.4, style B.3, style A.1and for wind analysis is REPLICA style A.1, style B.2, style B.3, style C.3, style C.4, style B.4, style B.1, style C.2, style A.4, style C.1, style A.3, style A.2.

Joint Displacement: Joint displacement in x-direction observed maximum value is seen in EQ.(ESM) and minimum in wind analysis. Similarly Joint displacement in y-direction observed maximum value is seen in EQ. (ESM) and minimum in wind analysis. The minimum value in x-direction chronological order of REPLICA style for ESM is REPLICA style B.1, style C.3, style B.2, style B.3, style C.1, style A.3, style C.2, style A.4, style A.2, style C.4, style B.4, style A.1 and for wind analysis is REPLICA style A.1, style A.3, style A.2, style B.3, style C.4, style A.4, style C.3, style B.2, style B.4, style C.2, style B.1, style C.1.

The minimum value in y-direction chronological order of REPLICA style for ESM is REPLICA style C.1, style C.3, style B.1, style A.3, style C.2, style A.4, style C.4, style B.2, style A.2, style B.4, style B.3, style A.1and for wind analysis is REPLICA style A.1, style A.3, style B.3, style B.4, style C.4, style C.3, style C.2, style C.1, style A.2, style B.2, style A.4, style B.

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