Wind Braces & Tie Runners as Mittigating Elements in Industrial Sheds Against Seismic Forces

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Abstract - In case of the seismic load some researchers of the Canadian Institute of Steel Construction, 2005 evaluated that in the case of seismic activity, the mass of the crane will interact with the mass of the supporting structure, but they do not refer to the influence of the hoist load. This research study basically deals with the dynamic performance of the industrial building subjected to the stated forces equipped with gantry cranes of different capacities and integrated with wind braces. The influence of wind braces in reducing the displacements has been studied. The dynamic parameters such as base shear, fundamental time period and the required tonnage has been set as the dominating parameters in deciding the performance.

Key Words: Dynamic Performance, Industrial building , Tie Beams, Wind Braces, Linear Structural Analysiss Stadd- Pro

1. INTRODUCTION

The seismic sequences that hit India in the once two decades have caused tremendous damage to the structures. Particularly the Bhuj earthquake of Gujarat state, Killare earthquake in Maharashtra region, has caused expansive damage to the erected terrain. colorful strips in these regions are now characterized by wide artificial belts, with several Reinforced concrete and sword structures numerous of which has been erected after the enforcement of ultramodernanti-seismic regulations and the bracket of the point seismicity of the India. In this study the geste of artificial structures under the influence of gantry crane loads as well as the dynamic conditioning due to earthquakes and winds has also been studied.

The structural layout of the considered artificial structures is made up of sword stake columns fixed at the base by means of corroborated concrete insulated box footings and by means of acceptable mechanical connections needed to anchor the foundation with the sword columns. The column top ends are projected to the sword rolled raised trusses. The pattern of the stilt rudiments is analogous to the multiple king post stilt rudiments, the tie of which is raised to an extent. The roof cladding is considered to be constituted of galvanised sheeting0.50 mm thick. The roof rudiments utmost of the times simply rest on the main stilt rudiments connected by simple outfit. The cladding on the external side faces constituted of slipup work up to 3m, and galvanised iron sheeting above that up to the top edge. The considered structures were generally designed for sustaining vertical wind loads, seismic forces, loads convinced by gantry cranes of different capacities, and the static loads. The vertical loads generally considered are those caused by the acceleration or retardation of the crane in relation to its movement along the runway ray, by the acceleration or retardation of the grouser in relation to its movement along the crane ground, by the skewing of the crane in relation to its movement along the runway ray, or by the collision with the buffers. also, the approach for the gantry crane and the swell forces has also been taken into consideration. It's veritably absorbing that vertical forces at the wheel contact face can be considered up to 10 of the maximum perpendicular wheel cargo which is suggested by numerous canons including Euro law 1991- 3, clause2.5.2. Some of the prominent authors considers this value as reference. In case of the seismic cargo some experimenters of the Canadian Institute of Steel Construction, 2005 estimated that in the case of seismic exertion, the mass of the crane will interact with the mass of the supporting structure, but they don't relate to the influence of the hoist cargo. This exploration study principally deals with the dynamic performance of the artificial structure subordinated to the below pronounced forces equipped with gantry cranes of different capacities and integrated with wind braces. The influence of wind braces in reducing the deportations has been studied. The dynamic parameters similar as base shear, abecedarian time period and the needed heftiness has been set as the dominating

1.1 Gantry Crane

Crane is generally a lifting device, used to elevate or lower loads vertically and to move them horizontally while they are hanged

A gantry crane is **a type of overhead crane that uses legs to support the bridge, trolley, and hoist**. These legs travel on along the ground on wheels or ride on rails implanted in the ground. A gantry crane is typically used for outdoor applications or for lifting capability below existing overhead bridge crane system

1.2DIFFERENT SEISMIC ANALYSIS PROCEDURES.

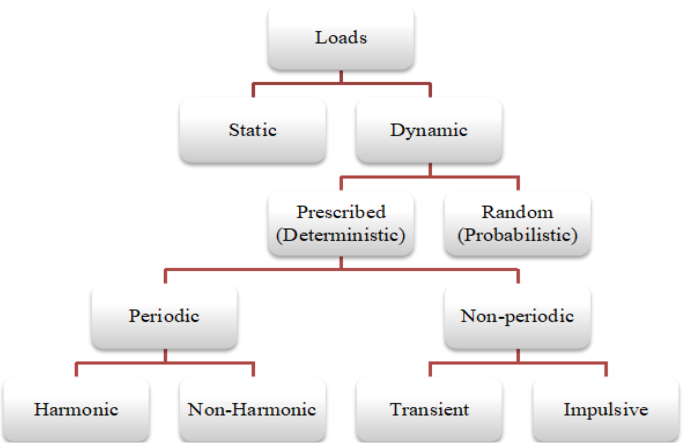


Fig. 15: Types of Loading

- Linear Analysis (it is carried out to dimension the structure and check to check that it resists according to the established regulations of the technical building code)
- Nonlinear Analysis (it was performed with the objective of verifying the ultimate Limit State of Stability of the structural elements and of the beams that whole
- Pushover Analysis
- Finite Element Method (modelling and analysis of gantry crane)

1.3 METHODOLOGY

Building structures are generally subjected to two types of loads viz. Static and Dynamic analysis. Static loads are constant while dynamic loads vary concerning time. Dynamic loads can be further subdivided as shown in Fig.15.

Neglecting any of these forces sometimes may become the cause of disastrous failure causing loss of life and property especially in case of earthquakes. The recent example of such losses is the Bhuj earthquake of January 26, 2001. Nowadays, as various high-rise structures are being constructed, which are compulsory to be properly designed with great care. For proper design of any structure, it is of prime importance to carry out the analysis properly with due care to estimate various loads and forces acting to its actual values. If the loads are underestimated the design would be of thinner sections which may not be able to withstand the forces liable to act in near future. On the other hand, if these forces are overestimated it may lead to the provision of sections uneconomical as there was no such force liable to act so large for which the sections have been designed.

2. LITERATURE REVIEW

M.Cacho-Perez [1]

Evaluated the ascendancy of using limit state method for the analysis and design of structural steel industrial building of double-T type section located in an industrial area of Valladolid (Spain). Firstly, a linear analysis was carried out to dimension the structure and check that it resists according to the established regulations of the Technical Building Code (CTE) and the national adaptation of the Eurocodes (ECs). For the analysis of the structure, the 3D model of slender bar bending (Navier-Bernoulli bending theory) and the non-uniform twist or constrained warping model (Vlasov's torsion theory) were considered. In the second place, a nonlinear analysis was performed with the objective of verifying the Ultimate Limit State of stability of the structural elements and of the industrial building as a whole. All this without the need to estimate buckling coefficients of each of the beams that make up the structure, and without the need for important simplifications.

Giovanni Fabbrocino Et Al. [2]

Studied the existing precast industrial sheds and buildings lying in Italy which were constructed during 1950's to 1970's some of which were lying within the seismically activated areas vulnerability of which have been studied and elaborated. The pushover analysis was performed for the determination of the seismic capacity of some reference precast industrial buildings, some open problems on the modelling of this structural typology are discussed in the article. Spectral analyses, conditioned by some simplifie

Fezayil Sunca, Mehmet Akkose [3]

This paper basically investigated the effects of semi rigid connections on seismic performance of prefabricated structures. Nonlinear static analyses (pushover analysis) of a selected RC prefabricated structure were performed with SAP2000

I. The prefabricated structures cannot be asflexible as the hinged connected structures since they have semirigid connections.

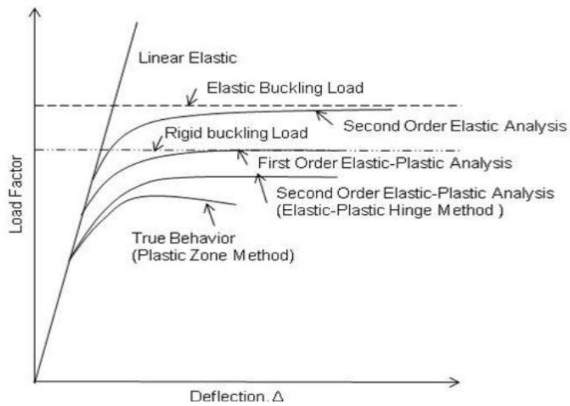
II. Comparing the fundamental periods of the selected RC prefabricated structure with uncracked and cracked sections in x and y-directions, it was apparent that the stiffness of the structure increased due to the semi-rigid connections.

Dr. M. Sri Ramamurthy, B.N. Nagababu [4]

This paper deals with modelling and analysis of gantry crane with different materials using finite element method. The crane is lifting machinery, discontinuous movement aimed at raising and distributing loads in space, suspended from a hook.

The Gantry cranes are one of the most important mechanical components in the heavy weight lifting and loading in to cargos, into trains, in to heavy truck vehicles, etc. Different types of gantry cranes available in the industries are container cranes, workstation gantry cranes (or) light weight mobile gantry cranes and semi gantry cranes. These vase verity of gantry cranes are differed base.

Shaik Kalesha, B.S.S. Ratnamala Reddy, Durga Chaitanya [5] Pre-engineered building concept involves pre-designed and prefabricated steel building systems. The current construction approach calls for the best architectural look, high quality & quick construction, cost-effective & creative touch. One has to think of alternative building systems such as pre-engineered steel buildings.



3. CONCLUSIONS

The following conclusions were drawn after the sheds were simulated and analysed for the different gantry and other loads:

From the structural response it can be concluded that the difference between the inertia forces attracted by the bare frames and the structures with wind braces will not be more than 6-8%. Hence it can be concluded that the base shear of bare frames and wind braced frames will be [1.] approximately same.

[2.]The inertia forces attracted by the structure under the influence of wind braces and their combination with tie beams proves to be more effective in repelling the base forces.

[3.]Secondly it can also be said that as the gantry crane capacity is directly proportional to the rate of reduction of displacements. Also, the influence of wind braces on the vertical deflections will not be considerable.

Validation of Time Period (Sec)			
	Paper Results	Validator Results	Percentage Variation
Support Reaction (kN)	128.529	121.931	5.41 %
Maximum Displacement (mm)	146.55	122.87	16.15 %
Maximum Moment (kN.m)	$293x10^3$	$261x10^3$	12.62 %

[4.]Though there was no much variation in the dynamic parameters of the structure for bare and wind braced frames it can be concluded that there is a huge difference in the structural steel demand of both the frames. Hence the wind braces make the structures economically feasible than that of the bare frames.

[5.]In comparison between the wind braces, tie beams and their combinations, wind braces demand lesser tonnage, controls deflection in a better way and makes the structure more rigid. Hence, it can be concluded that wind braces are the most effective and feasible method which can be used in industrial shed subjected to dynamic forces

Validation

As described in the precursory modules this research study was intended to evaluate the performance of industrial steel buildings under the influence of gantry crane loads additionally with wind and seismic loads. The structures were modelled and analysed in the computer aided analysis and design code Staad Pro (SS6). Under this module the validation of the present study has been discussed. For the validation purpose a research paper entitled as, "OPTIMUM DESIGN OF AN INDUSTRIAL WAREHOUSE USING STAAD-PRO", has been considered. The structures analysed under this paper were again modelled in Staad Pro (SS6) so as to validate the range of the results gained from the analysis. The frames simulated under this paper were analysed for the properties and specifications considered from the Indian codal provisions (IS-800-2007) and as specified in the article. Following properties and specifications were taken into account for validation.

Properties	Considerations
Type of truss	Howe truss
span of truss	25 m
Rise of truss	3.0 m
Spacing between two columns	5.0 m
Height of column	8.0 m
Type of roofing	GI Sheeting
Number of frames	6 No's
Weight of GI Sheet	0.112kN/M^2
Weight of fixings	0.025 kN/M^2
Weight of bracing	0.012kN/M^2
Load on each panel point	2.35 kN
Load on each end panel point	1.18 kN

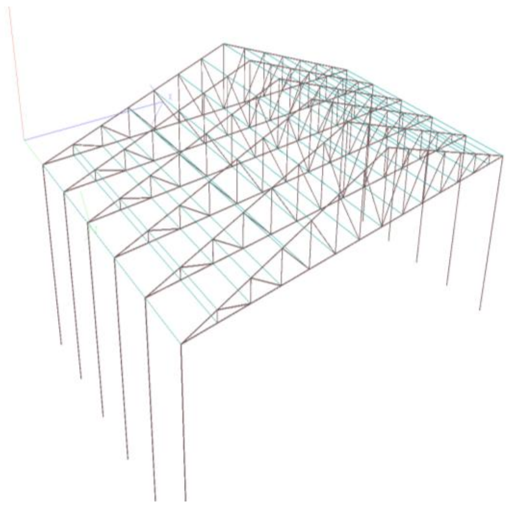


Figure1: 3D Extruded View of Validatory Model

For the purpose of validation as described earlier, the data given in the validators paper was considered and a fresh simulation of the structures were remodelled in Staad Pro (SS6). The results of the same has been specified in table 12 and 13. The results were found to be in the range as specified in the research article, hence validation was achieved.

Table 1: System of Simulations

DESIGNATION OF MODEL	OPENINGS (%)	GANTRY LOAD APPLIED (Tonne)
MODELS WITH WIND BRACES		
BF20-2.5	LESS THAN 5	20 T
BF20-5.0	GREATER THAN 5	20 T
BF30-2.5	LESS THAN 5	30 T
BF30-5.0	GREATER THAN 5	30 T
WB20-2.5	LESS THAN 5	20 T
WB20-5.0	GREATER THAN 5	20 T
WB30-2.5	LESS THAN 5	30 T
WB30-5.0	GREATER THAN 5	30 T
MODELS WITH TIE BEAMS & COMBINATIONS		
TB20-2.5	LESS THAN 5	20 T
TB20-5.0	GREATER THAN 5	20 T
TB30-2.5	LESS THAN 5	30 T
TB30-5.0	GREATER THAN 5	30 T
CB20-2.5	LESS THAN 5	20 T
CB20-5.0	GREATER THAN 5	20 T
CB30-2.5	LESS THAN 5	30 T
CB30-5.0	GREATER THAN 5	30

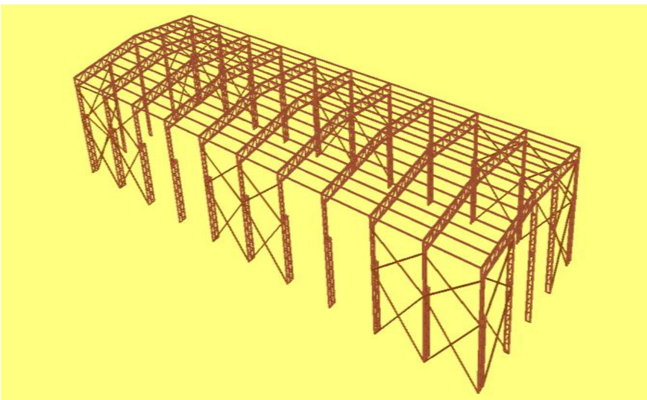


Figure2: 3D Extruded View of WB Models

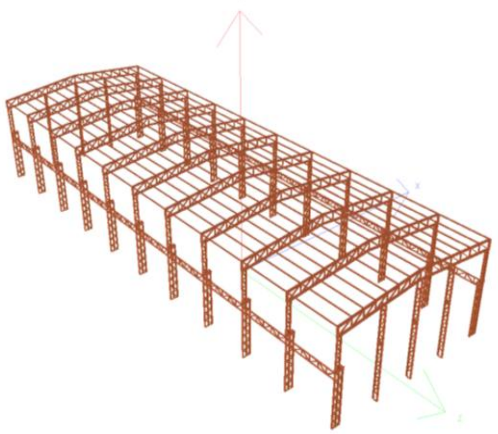


Figure 3: 3D Extruded View of TB Models

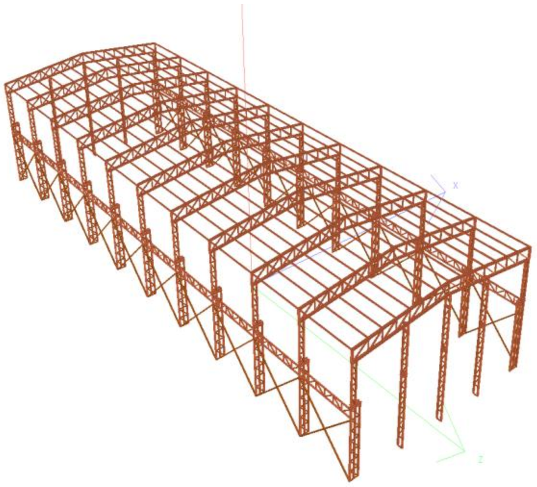


Figure 4: 3D Extruded View of CB Models

REFERENCES

1. M. Cacho-Perez, "Design and analysis of an industrial steel building. Limit states, stability check", Procedia Engineering, Elsevier, Volume 153, 2017, PP. 342-353.

2. Giovanni Fabbrocino, Gennaro Mugliulo, "Seismic assessment of existing precast industrial buildings using static and dynamic nonlinear analyses", Engineering Structures, Elsevier, Volume 30, 2008, PP. 2580-2588.

3. Mehmet Akkose, Fezayil Sunca, Alperen Turkay, "Pushover analysis of prefabricated structures with various partially fixity rates", Earthquakes and Structures, Volume 14, 2018. PP. 21-32

4. Andrea Belleri, Simone Labo, "Design of diagrid exoskeletons for the retrofit of existing Industrial buildings", Engineering Structures, Elsevier, Volume 220, October 2020, PP. 1188

5. E. Bonamente, M.C. Merico, "Environmental Impact of Industrial Prefabricated Buildings: Carbon and Energy Footprint Analysis Based on an LCA Approach", Energy Procedia, Elsevier, Volume 61, 2014, PP. 2841-2844

6. Fezayil Sunca, Mehmet Akkose, "Seismic Response of a Prefabricated Industrial Structure to Multiple Support Seismic Excitations", 2nd International

7. Conference on Civil and Environmental Engineering Symposium, May 2017

8. Fangxin Hu, Gang Shi, "Experimental study on seismic behavior of high strength steel frames: Local response", Engineering Structures, Elsevier, Volume 229, 2021, PP. 151-162.

9. Dr. M. Sri Ramamurthy, B.N. Nagababu, "Modelling and Analysis of Gantry crane with Different Materials Using FEM", International Journal of Scientific Development and Research – IJSDR, Volume 4, Issue 1, January-2019. PP-229-239

10. Jae-Yuel Oh, Deuck Hang Lee, "Flexural Behaviour of Prestressed Steel-Concrete Composite Members with Discontinuous Webs", Advances in Materials Science and Engineering, Volume 2015, May 2015