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BEHAVIOR OF DOUBLE SKIN FLAT COMPOSITE WALL UNDER LATERAL LOAD

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Abstract— Shear walls are the primary lateral load-carrying elements in tall buildings. The composite shear walls with double steel plates and filled concrete are composed of two steel plates with studs inside, they were developed to enlarge the building space, and to delay the appearance of cracks by using the steel plates as formwork. Double skin composite wall panels can offer high strength and robustness while improving the convenience of construction, with great potential for application in nuclear power plants. This paper studied the behavior of double skin flat composite wall with several different plate thickness and stiffeners shape (L, T) The models subjected to axial and wind load to present more information to the structural designers and to improve the DSFCW to be used widely in engineering construction. The DSFCW like any other structure element need to be improved and strengthen when is subjected to any type of load so it's important to find the optimum strengthening technique.

Index Terms— Structure Engineering, Civil Engineering, Composite Walls, Stiffeners, Windload, DSFCW, Simulation FEM.

1 Introduction

THe composite steel plate shear walls are executively simple, and there is no particular complexity in the system, thus engineers, technicians and technical workers with their technical knowledge and without having to learn new skills can perform the system. Work precision is at the level of conventional precision in steel structures and with that consideration, there will result much higher executive safety factor compared with the other systems. Due to its simplicity and the possibility of constitution in a factory and installed on the site, system executive speed is high and the enforcement costs will be reduced significantly

The composite steel plate walls structure usage has been increasing especially due to their extremely low weight that leads to reduction in the total weight and fuel consumption, high flexural and transverse shear stiffness, and corrosion resistance (ASM Handbook 2004). The composite steel walls consist of two steel plates with studs inside and two steel tubes with concrete filled aside.

The steel plates can be used as the formworks for the concrete filler during construction and they can also delay the appearance of concrete cracks. Steel plate-concrete composite walls are lately developed forms of structural walls compared to the traditional reinforced concrete (RC) wall.

The double-skinned flat steel sheets infill with concrete composite wall (DFSCW) have been used as load resisting systems in building structures in the past, especially in United States since 1970's when initially they were used for seismic retrofit of low and medium-rise existing hospitals and other structure. The lateral and gravity load-resisting system consists of reinforced concrete walls and reinforced concrete slabs. Composite steel walls are the main vertical structural elements with a dual role of resisting both the gravity and lateral loads (Edificios Chilenos de Hormigón Armado, 2002. Ed. ICH, Chile).

2 PARAMETRIC OF STUDIES

The study suggested to investigate the behavior of double skin flat composite wall plate thickness of 4mm, 6mm, 8mm, each steel plate will enhance by adding different stiffeners shape of L and T. The models will be subjected to axial and wind load to present more information to the structural designers and to improve the DSFCW to be used widely in engineering construction. Moreover, the DSFCW like any other structure element need to be improved and strengthen when is subjected to any type of load so it's important to find the optimum strengthening technique.

2.1 AXIAL LOAD RESULTS

To Study the effect of steel plates thickness and several shapes of stiffeners, several specimens will be modeled to insure that the result is satisfied with the elements. Six specimens with different plate thickness of 4mm, 6mm, 8mm each steel plate fabricated with two different shapes of stiffeners DSFCW – (L, T) as it showing below in table 4.1 the specimens will be compared in terms of displacement. Figure 4.1 below showing the results of axial load.

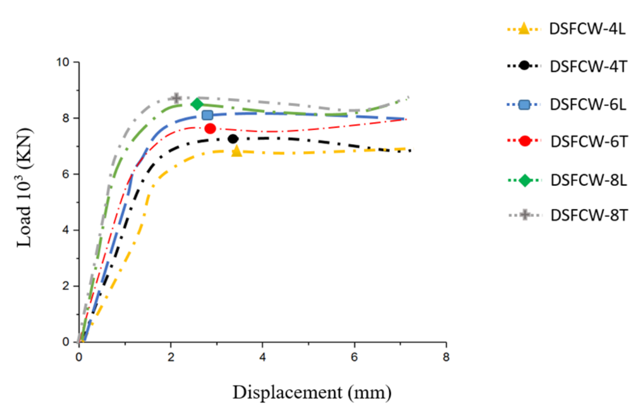

Figure 4.1

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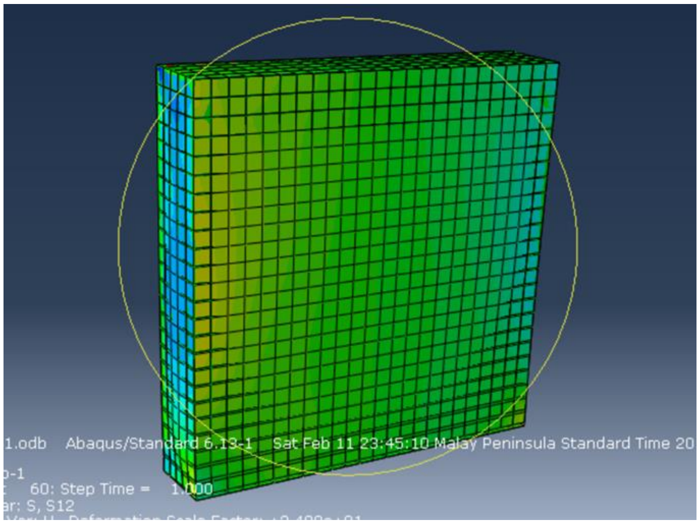


Figure 4.2 DSFCW-8T under ultimate axial load

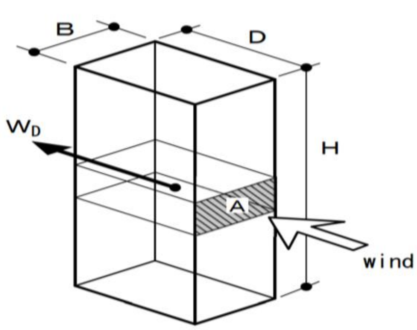
3 WINDLOAD CALCULATION

Summary Design Wind Load Calcualtions

Step 1
Site wind speed
Vsit = Ms*(Md)*(Mz,cat)*(Ms)*(Mh)
Vs = 25.125 M/s

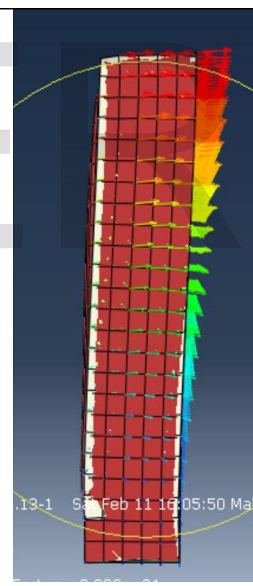
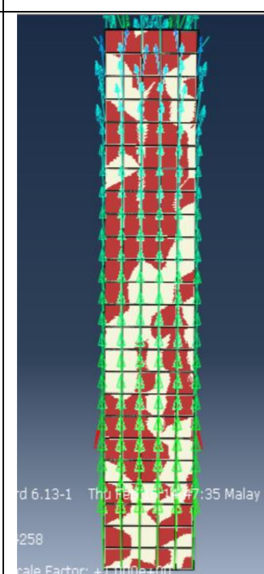
Step 2
Design wind speed
Vdes = Vsit × I
Vdes = 28.89375 M/s

Step 3
Windward pressure
P = (0.5 ρair)* [Vdes]^2 *Cfig *Cdyn
P = 255.881 Kpa
Leeward Pressure
P = (0.5 ρair)* [Vdes]^2 *Cfig *Cdyn
P = 153.529 Kpa
Side wind
P = (0.5 ρair)* [Vdes]^2 *Cfig *Cdyn
P = 0.061 Kpa.



4 LATERAL DEFORMATION (DRIFT)

The lateral deformation for DSFCW-8T, the model is at the recommended allowable deflection limit which is (18.37 mm) it is indicated that the results obtained from the FE method are in good agreement with the code of practice on wind loading for building structure (MS 1553 : 2002), however the other specimens has giving results within the range of the allowable deflection limit but in structural engineering, designers will always focus on the minimum deformation of any element in order to insure the factor of safety as a priority factor and also to make sure of their high in plane stiffness and strength to suite for high-rise buildings of up to about 25 stories. Table 4.10 below show the failure mode due to high wind force comparing to the DSFCW-8T specimen.

Parameter	Failure mode	DSFCW-8T
Height	87.5 m	87.5 m
No. of Storey	25	25
Allowable sway (H/500)	175 mm	175 mm
Lateral deflection	more than allowable limit	(18.37) within the allowable limit
Model deformation view		

5 SUMMARY

FE results of double skin flat composite wall tested under axial load and wind load. Specimens modeled by using ABAQUS FE software. 12 specimens have been tested. The study indicates that the optimum shape of the stiffeners which is T shape comparing to L shape under axial load. Second group of DSFCW has been tested under lateral load to determine the minimum drift. Therefore, specimens showing a mechanical improvement during the FE analysis especially the DSFCW specimens that modeled with 8mm plats thickness and fabricated with T shape stiffeners.

6 CONCLUSIONS

Deflection of structure can occur from various sources, such as loads, temperature, fabrication errors, or settlement. In structural design, lateral loading become one of the important element that need to be considered because it may have significant influence on the lateral response of the structure for thus effect the overall stability of the structure.

Large aspect ratio, will affect the visual dominance of a tall building and consequently the aesthetic quality. This research mainly concentrated with the study of lateral deflection due to wind load action on double skin flat composite in high-rise structural systems.

From this study conducted, different plates thickness and stiffeners shape minimized a different variations of lateral deflection drift limit. Theoretically and practically adding these materials in order to reduce the effects of deflection caused by wind or load action. This study has proven that the double skin composite wall system can resist against lateral deflection, steel walls were between the allowable limits of lateral deflection (h/500).

The models have been successfully designed using ABAQUS software. Based on the analysis of the results obtained from this research, and taking into account the objectives of this research the following conclusions are summarized

1. In terms of the axial load compression the DSFCW-8T with plate thickness of 8mm has showing improvement in load stability.

2. In terms of deflection response to lateral load, this is clearly showed in the lateral load deflection response. T-shape stiffeners has showing a low deflections as compared L-shape stiffeners.

3. double skin composite walls is more efficient in functioning as a lateral load resisting system even though the different is not much but it still considered more efficient. In terms of wall deformation..

7 APPENDIX

A- FE result of different meshing specimens

Specimens No.	FE specimens (kN)	Displacement
MESH 40	10984	3.80
MESH 50	9925	3.34
MESH 60	9301	2.76
CONTROL	11249	3.57

B- FE result for new double skin flat composite wall specmens

Specimens No.	FE specimens (kN)
DSFCW-4L	6200 KN
DSFCW-4T	6744 KN
DSFCW-6L	7559 KN
DSFCW-6T	7859 KN
DSFCW-8L	8304 KN
DSFCW-8T	8901 KN
MESH 50	9925 KN

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