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A COMPARATIVE STUDY ON LATERAL STIFFNESS OF PLATING AND PLAN BRACES IN OFFSHORE DECKS

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ABSTRACT

This paper focuses on the behavior of plating and plan braces in fixed offshore decks for various structural configurations. A frame of a typical offshore deck is analyzed using Staad Pro software. A live load of 5 kN/m^2 is considered with other items like secondary beams, handrails, grating and lateral loads. Stiffness of secondary beams is ignored. The structural configurations studied are: a 30 mm thick grated model with plan braces, 8mm thick plated model with plan braces and 8 mm thick plated model without plan braces. By this comparative study it is observed that the plan braces take considerable lateral loads only in the grated models. In the plated models, the lateral stiffness of the plating predominates.

Key words: Offshore Deck, Lateral Stiffness, Plating and Plan Braces.

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1. INTRODUCTION

Plan braces contribute to the lateral stiffness of structural frames. In fixed offshore decks, the plan braces are usually tubular members attached to the bottom flange of primary I Beams with a gusset plate. Though they are not employed in every panel, their presence in a few bays of a frame contributes to lateral stiffness of offshore decks. However in the areas like cellar deck where the structure is primarily plated, it is necessary to ascertain the role of plan braces

in taking lateral loads since plating contributes to considerable lateral stiffness of the structure.

Junling Chen et al. 2012 [1] studied how the horizontal bracings will contribute to the resistance of a steel moment frame against progressive collapse. Two models were prepared, one with horizontal braces and one without horizontal braces. These models were studied and analyzed using ANSYS software. With this analysis it was concluded that the arrangement of horizontal braces was an effective means to improve progressive collapse resistance.

Zasiah Tafheem and Shovona Khusru, 2015 [2] studied and investigated the performance of the steel building for different types of bracing system. The two most important types of bracings used were concentric bracings and eccentric bracings. The analysis was done using ETABS 9.6.0 software. The structure was studied in terms of lateral displacement and storey drift. It was concluded that concentric bracings have more lateral stiffness than eccentric bracings. A comparative study on the behavior of plan braces in plated areas and grated areas of offshore decks is presented in this paper.

2. STRUCTURAL MODELING

A frame of an offshore deck with a 25 m x 25 m plan area is considered for the analyses. The structural configurations studied are

a) 30 mm thick grated model with plan braces

b) 8mm thick plated model with plan braces and

c) 8 mm thick plated model without plan braces.

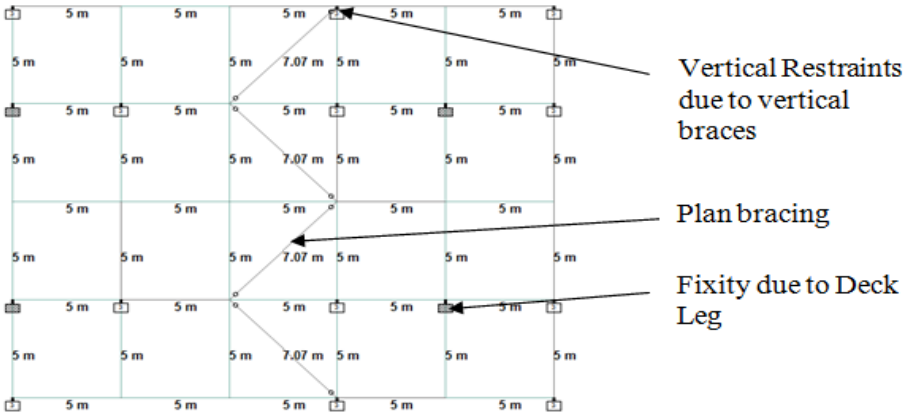

Figure 1 Top view of grated and plated models with plan brace

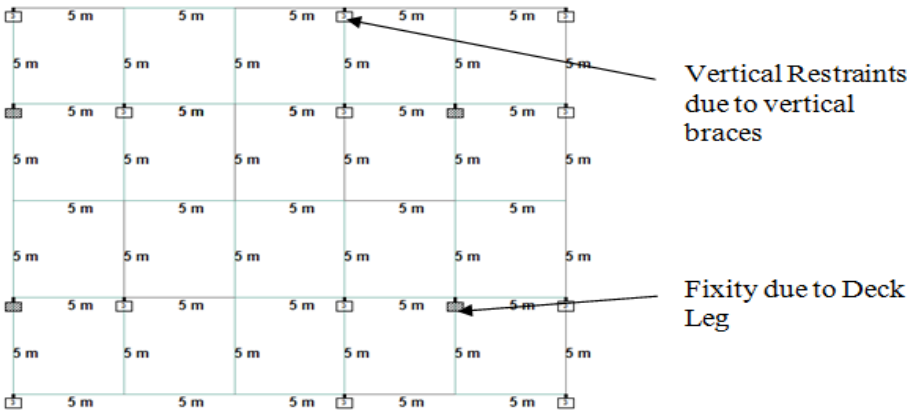

Figure 2 Top View of plated model without plan brace

Yield Strength of steel used is 345 MPa. The following member sizes are adopted.

Table 1 Member Properties

S.No	Primary Beam sizes(mm)	Secondary beam sizes(mm)	Plan Braces (Dia. x Thk.) Mm	Grating Size(mm)	Plating Size(mm)
1.	UB 610x229x125	UB 356x171x45	273x12.7	30	8
2.	UB 686x254x125	UB 356x171x45	273x12.7	30	8
3.	UB 762x267x134	UB 356x171x45	273x12.7	30	8
4.	UB 838x292x176	UB 356x171x45	273x12.7	30	8
5.	UB 914x305x201	UB 356x171x45	273x12.7	30	8

3. LOADING

A uniformly distributed live load of 5 kN/m^2 is applied on the primary beams. For the grated models, a 30 mm thick grating having a self weight of 0.50 kN/ m^2 is applied as uniformly distributed load (UDL) on the primary beams. For the plated models the 8 mm thick plates are modeled and the weights computed by the software. The secondary beams are not modeled but the weight of secondary beams UB 356x171x45 is applied as UDL on primary beams in all models. Handrail weights (0.3 kN/m) are applied on the periphery beams alone. A concentrated 10 MT lateral load due to deck crane operations is applied at appropriate points where the plan brace join the periphery primary beams.

Table 2 Loading on grated model

S. No.	Item	Loading Intensity	Type
1	Self weight	Based on density of material	Gravity
2	Live load	5 kN/m^2	Area load
3	30 mm thick Grating	0.50 kN/m^2	Area load
4	Handrails	0.30 kN/m	UDL on periphery beams
5	Secondary beams	Calculated UDL value based on beam weight of 45kg/m and number of beams	UDL in X direction beams
6	Lateral load	10 MT lateral load due to deck crane	Point loads at appropriate location
Load Combination: 1+2+3+4+5+6			

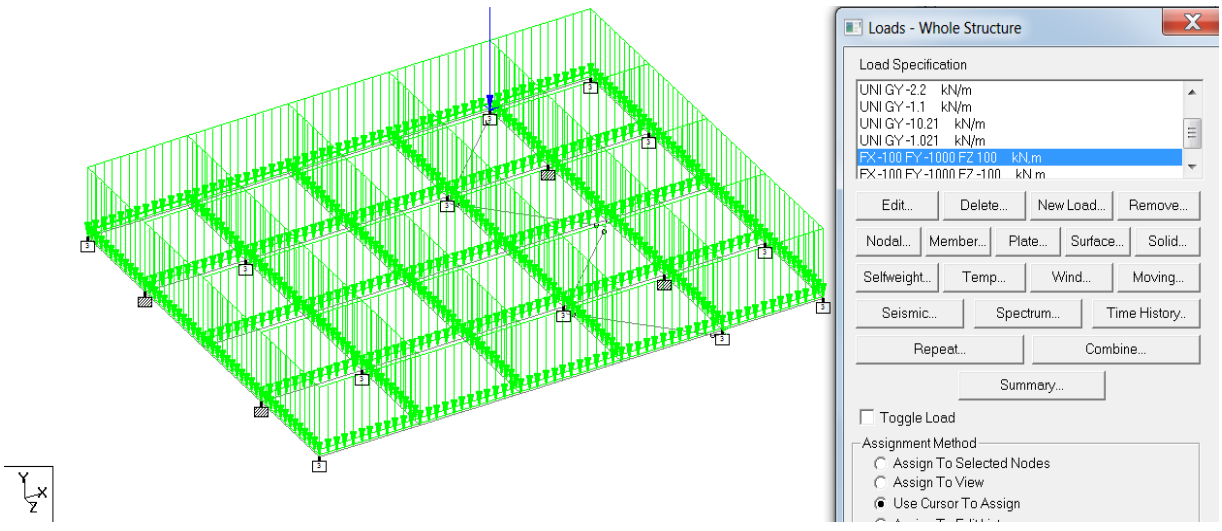

Figure 3 Loading on Grated/Plated Model

Table 3 Loading on plated model with/without plan braces

S. No.	Item	Loading Intensity	Type
1	Self weight	Based on density of material	Gravity
2	Live load	5 kN/m^2	Area load
3	8 mm thick Plating	Based on density of material	Gravity
4	Handrails	0.30 kN/m	UDL on periphery
5	Secondary beams	Calculated UDL value based on beam weight of 45kg/m and number of beams	UDL in X direction beams
6	Lateral load	10 MT lateral load due to deck crane	Point loads at appropriate location
Load Combination: 1+2+3+4+5+6			

4. RESULTS

The unity check ratios from the linear static analyses performed for various structural configurations are presented here:

Table 4 Unity Check Ratios

S.No.	Primary Beam Section	Unity Check Ratio		
		Grated Model	Plated Model with plan braces	Plated Model without plan braces
1.	UB 610x229x125	1.05	1.00	0.842
2.	UB 686x254x125	0.748	0.723	0.716
3.	UB 762x267x134	0.644	0.619	0.614
4.	UB 838x292x176	0.549	0.404	0.400
5.	UB 914x305x201	0.456	0.329	0.327

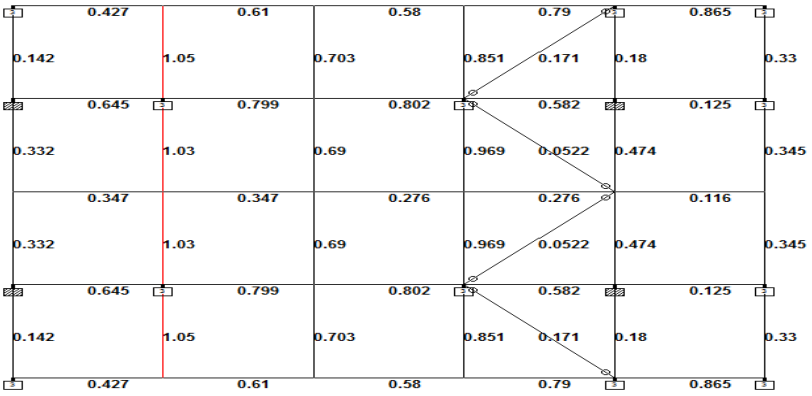

Figure 4 UC ratios for grated model (Primary beam - UB 610x229x125mm)

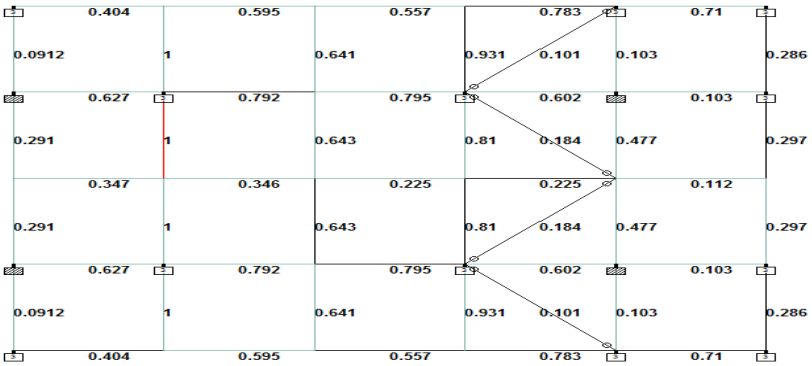

Figure 5 UC ratios for plated model with plan braces (Primary beam - UB 610x229x125mm)

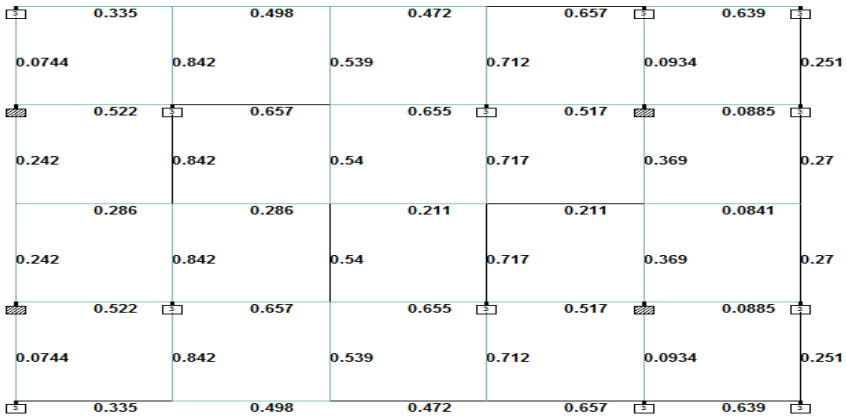

Figure 6 UC ratios for plated model without plan braces

(Primary beam - UB 610x229x125 mm)

5. CONCLUSIONS

It can be observed from Table 4 that the unity check values reduce as beam size increases. The stresses in beams and plan braces are highest for the models with grating and plan braces. The stresses reduce for the models with plating and with plan braces. The stresses in the beams are the minimum for the models with plating and without plan braces as the stiffness of plate helps in taking all lateral loads. From the above study it is concluded that lateral stiffness of plates is more than plan braces. However the necessity of plan braces in plated regions need to be evaluated for different cases based on FEM analyses and experimental studies.

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