

Numerical Analysis of Innovative Eccentric Overlapped Demountable Joint for Jacket Structures

Maria Jose¹, Asha Jose²

¹PG Student, Dept. of Civil Engineering, Indira Gandhi Institute of Polytechnic and Engineering, Kerala, India

²Assistant Professor, Dept. of Civil Engineering, Indira Gandhi Institute of Polytechnic and Engineering, Kerala, India

Abstract - jacket substructures used to resist high environmental forces.. To replace X-braced jackets, The jacket is comprised of completely overlapped joint at every joint. In comparison to the X-braced jacket the jacket with overlapped joint has several advantages in terms of load transfer and reduced number of welded joints and shorter thicker walls. The jacket structure mainly comprises of three members they are chord, through brace, lap brace. The chord is the main member here and lap brace is the sacrificing element. There is only the study of completely overlapped joint. In this making the models of joints as joint with GAP, overlapped joint, demountable overlapped joint and demountable GAP joint. from the study understand that the overlapped joint on demountable condition performed well in the case of load carrying capacity and stress on the through brace and lap brace also reduces. On other study is done with stiffeners four types of joints are used here. Demountable joint with ring stiffener, demountable joint with external gusset plate, demountable joint with external fin stiffener and demountable joint with internal fin stiffener. from the study it is clear that ring stiffener performs better. hence the life of the joint and life of the jacket structure will increase

Key Words: Jacket structure, Completely overlapped joint, Demountable joint, demountable joint stiffeners

1. INTRODUCTION

Eccentric jacket sub structures used for to resist the environmental forces. the jacket structure mainly comprises of X braced joints with welded connection. When considering the environmental forces it is necessary to enhance the flexural rigidity. The jacket structures subjected to large forces if it is in any condition like both in operating or off-service conditions. These loads will transfer through the diagonal braces to the foundation. the joints play very important role in the case of load transfer. So, there is a need of better structure system, the typical X braced joints are replaced by completely overlapped joint at every connection. These type of overlapped joint has many advantages than the X braced joint. it will reduce the number of welded joints. generally joint failure will occur at the chord wall. the structure consist of completely overlapped joint at every connection. The joint consist of a chord and two braces in a single plane. The two braces are fully overlapped with a short segment of the diagonal brace. The

short segment member is designed to absorb and dissipate energy under cyclic load. This short segment member can be designed to dissipate and absorb energy generated by load excitation. The inelastic yielding and local buckling of the short segment member also enable the jacket substructure to remain stable under gravity loads and to sustain intense environment forces or earthquake without collapsing after yielding.

2. FINITE ELEMENT MODELING

2.1 General

To investigate the structural performance of different types of joints for the jacket structure. modeling of structure was done in ANSYS 16.1

2.2 Objectives

To study the performance of gap joint, overlapped joint And the effective joint is taken for further demountable conditions. The conditions are; overlapped joint with the demountable condition and the gap joint with the demountable condition. Then to improve the performance of connection by stiffening methods by demountable ring stiffener, demountable gusset plate, demountable external fin stiffener and demountable internal fin stiffener. To study the performance of joints with out plane loading condition. To study about the output parameters like ultimate deflection, ultimate load, yield load, tensile plastification.

2.3 Scope

To improve the joint stability and designing the demountable joint with semi rigid conditions avoid the premature weld failure subjected to out plane loading.

2.4 Geometry and material properties

Different models have been created using ANSYS software with the properties like yield strength, poisson's ratio, etc of joints. The model is with the dimension of the chord length is 2640mm chord diameter is 219.1mm and the chord thickness is 7.9mm The total length of through brace is 1870mm, through brace diameter is 168.3mm and the through brace diameter is 7.1mm. the through brace inclined at an

angle of 30 .the lap brace of length 6230mm,lap brace diameter is 88.9mm and the lap brace thickness5.5mm.

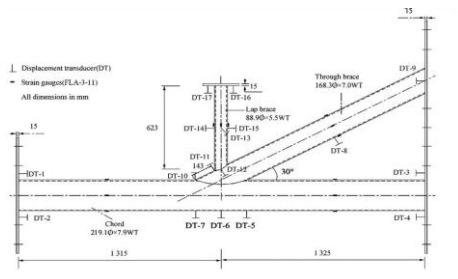
In total there were 8 models of joint , 4 models of joints is for to study the performance of gap joint and overlapped joint and then the effective joint is taken for further demountable conditions. In that 4 models of joints for to improve the performance of connection by the stiffening methods.

Performance study models of joints are

- [1] GAP joint
- [2] Overlapped joint
- [3] Demountable overlapped joint
- [4] Demountable GAP joint

Stiffening method models of joints are

- [5] Demountable ring stiffener
- [6] Demountable gusset plate
- [7] Demountable external fin stiffener



- [8] Demountable internal fin stiffener

Figure- 1;Geometric parameters of a completely overlapped joint

2.5 Boundary conditions

Axial support is given at one end of the chord and lateral loading is given at another end.lap brace and through brace are in pinned condition

3. RESULTS AND DISCUSSIONS

	DEF(mm)	Load(KN)	% increase in load	Stress-through brace	Stress-chord
Gap joint	21.21	828.46	1.00	462	582
Overlapped joint	23.27	907.16	8.68	521	499
Demountable Overlapped	30.75	937.03	13.11	457	497

joint					
Demountable gap joint	30.78	904.67	9.20	409	469

Table- 1; Ultimate load and Total deformation of joint models with GAP,overlapped, demountable with GAP joint

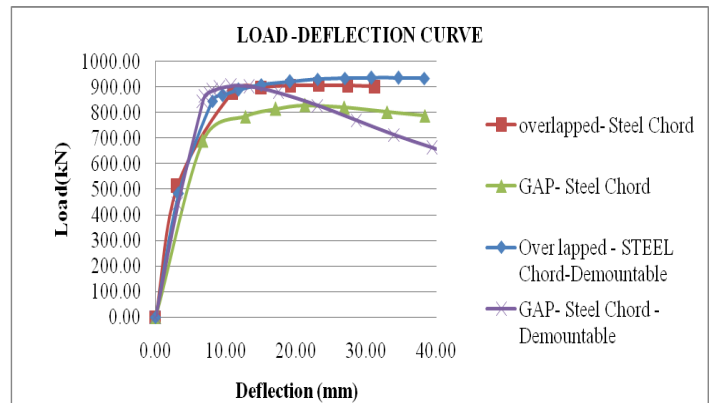


Figure-2; load deflection graph of gap, overlapped, demountable gap and overlapped joints

These results are the comparison of four type of joint conditions ; GAP joint, overlapped joint, overlapped joint with demountable condition, GAP joint with demountable condition. From the results It is clear that overlapped joint with demountable condition is more effective. The load carrying capacity is increased by 13.11 %.and the stress at the chord and through brace also reduced. It will help to increase the life of the jacket structure.

	DEF(mm)	Load(KN)	% increase in load	Stress-through brace	Stress-chord
DM-overlapped joint	30.75	937.03	1.00	457	497
DM-RS	10.42	1015.90	8.42	492	420
DM-GP-EX	10.26	999.07	6.62	451	377
DM-FS-EX	10.00	1010.50	7.84	503	462
DM-FS-IN	8.36	1010.10	7.80	462	415

Table- 3; Ultimate load and Total deformation of joint models with GAP,overlapped, demountable with GAP joint

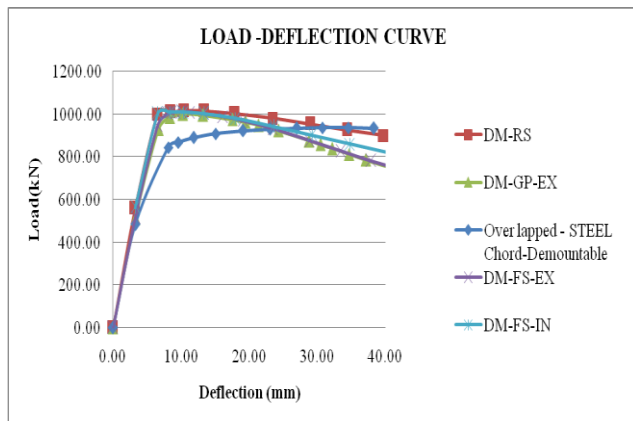


Figure- 3; load deflection graph of stiffeners

There is an increase in efficiency of joints with stiffeners than the overlapped demountable joint. Four types stiffening methods are used here. From the results it is clear that for demountable joint with ring stiffener, there is an increase in load of 8.42%. then in the case of demountable joint with gusset plate, 6.62% of increase in load occurred. 7.84 load increase for demountable joint with external fin stiffener and 7.80 for demountable internal fin stiffener.

In above all four cases demountable joint with ring stiffener is the best stiffener. Because it has more load carrying capacity than other stiffening methods. also it reduces the stress in the chord by 497.00 and also reduces stress in the through brace by 457.00. hence ring stiffener is more effective and other stiffeners performance slightly differ with RS.

4. CONCLUSIONS

From the study, following conclusions were arrived,

- In comparison with gap joint and overlapped joint load carrying capacity is more for overlapped joint. 8.68% increase in the load. stress in the chord and through brace also reduced
- In comparison with demountable overlapped and demountable gap joint, demountable overlapped joint perform better. it has an load increase of 13.11%. and also reduces stress in the chord and through brace.
- While comparing these four conditions, demountable overlapped joint has the better performance.
- While comparing the four stiffening methods, demountable ring stiffener has the higher load carrying capacity. it also reduces stress in the chord and stress in the through brace

- Stiffeners perform better in joints than other conditions. and it will increase the life of the joint. also increases the life of the jacket structures.

REFERENCES

- [1] Wie Min Gho, Ye Yang (2019) "Ultimate strength of completely overlapped joint for fixed offshore wind turbine jacket substructures". Journal of Marine Science and Application 18;99-113.
- [2] Yeter B, Garbatov Y, Guedes Soares C (2016) "Evaluation of fatigue damage model predictions for fixed offshore wind turbine support structures". Int J Fatigue 87:71-80.
- [3] Gao F, Hu B, Zhu HP (2013) "Parametric equations to predict LJF of completely overlapped tubular joints under lap brace axial loading". J Constr Steel Res 89:284-292.
- [4] Gho WM, Yang Y (2008) Parametric equations for static strength of tubular circular hollow section joints with complete overlap of braces. J Struct Eng ASCE 2008(3):393-401.
- [5] Fie Gho, Biao Hu (2015) "Local joint flexibility of completely overlapped tubular joints under out-of-plane bending"
- [6] Gao F, Gho WM (2008) Parametric equations to predict SCF of axially loaded completely overlapped tubular circular hollow section joints. J Struct Eng ASCE 2008(3):412-420.
- [7] Gho WM, Yang Y (2005) "Cyclic performance of completely overlapped tubular joints". Proceedings of The 15th International Offshore and Polar Engineering Conference, ISOPE, Seoul, Korea, 320-324.
- [8] Gho WM, Fung TC, Soh CK (2003) "Stress and strain concentration factors of completely overlapped tubular K (N)-joints. J Struct Eng ASCE 129(1):21-29.