

COMPARATIVE STUDY AND DESIGN OF FIXED OFFSHORE DECK STRUCTURE BY IS-800-2007 AND AISC 360-10.

Manjunatha C M¹, Mr. Sathish Kempaiah², Mrs. Sahana T S³

¹M.Tech student, Department of Civil Engineering, Sri Siddhartha Institute of Technology, Tumakuru, India

² Principal structural engineer, Aker solutions.

³ Assistant Professor, Dept. of civil Engineering, Sri Siddhartha institute of technology, Karnataka, India

Abstract - The main objective of this present investigation is to understand the Design criteria of two code's considering in the design off shore deck structure, comparing the design consideration's criteria, load factors, material factor's and design strength for two code's. The Deck is considered as fixed base assumption.

In the present study the behavior of superstructure by modeling in the Staad model, modeling of structural element by staad by considering all the elements are steel and they are all coated with corrosion lees paints, all the member's having the same property of Fe 410 grade. The analysis of Structure by in-place analysis using STAAD-Pro-V8i software. Typical design spread sheets developed for the design of Deck members subjected to axial, bending and combined axial & bending loads have been developed for different codes mentioned above and compared with STAAD design results.

The Member strength Utilization Ratios ($UCR = \text{actual load/allowable load}$) is compared for both codes.

Key Words: member strength comparison; load consideration and calculation; modelling and analysis; STAAD Pro V8i; strength comparison; bending moment; comparative results.

1. INTRODUCTION

The offshore plat form is an structure where as to use to extraction oil and gas from sea bed. In our India there are few plat form are there because of the oil exploration is not available in our India's area so that there is small scale of extraction from few regions, there are Mumbai high, eastern offshore vishaka pattana.

The first oil offshore platform in the world is the Oil Rocks (Neft Daşları), built near Baku in Soviet

Union. Building on the platform began in 1949, with Soviet Tankers transporting Oil from the first Well to Baku in 1951. The Oil Rocks lies 45–50 km (about 25 nautical miles) offshore on the Caspian Sea. The most unique feature of the Oil Rocks is that it is actually a functional city with a population of about 5000. The Oil Rocks is a city on the sea, with over 200 km of streets built on piles of dirt and landfill. Most of the inhabitants work on shifts; a week on Oil Rocks followed by a week on the shore. Offshore platforms are used for exploration of Oil and Gas from under Seabed and processing. The First Offshore platform was installed in 1947 off the coast of Louisiana in 6M depth of water. Today there are over 7,000 offshore platforms around the world in water depths up to 1,850M.

In general design practice for dynamic loading assumes the deck frames are fixed at their base. In reality the supporting on jacket stiffness of the system. The loads and load cases on deck structure are considered as per code of off shore construction. the loads and load cases are considered in design are same for two codes, The designing as per the two codes.

1.1 Types of Offshore Plat forms

There two types of offshore plat forms.

a. fixed offshore: In this type there are some types of off shore are there, they are

1. complaint tower
2. jackup plat form
3. concrete gravity

b. floating offshore: In this type there are some types of off shore are there, they are

1. tension legged plat forms
2. semi sub merged
- 3.spar platforms

Present study: The complaint (fixed steel) tower's deck is considered for design.

1.2 Methodology

Steps of the structural design;

- Typical loads applicable to the design of Industrial structures, such as dead, live, wind ,temperature loads and installation loads are considered. Load combinations as per respective codal stipulations and Industry Practice have been used.
- The analysis has been carried out by using STAAD Pro and the results of this analysis are used for the design of the structural members, by using STAAD supported design modules of IS and AISC codes.
- The structural analysis is by in-place analysis, and design as per LSD or LRFD method of design
- Member strength utilisation ratio (UCR) for axial, bending, combined axial and bending loads have been established by considering design parameters as per applicable code and UCRs for different members are compared.
- Typical design spread sheets have been developed for the design of component members subjected to axial (tension/compression), bending and combined axial & bending loads with appropriate load and safety factors as per IS 800:2007 and AISC. These spread sheets have been used to validate the results obtained from STAAD design.
- The partial safety factors for loads and materials adopted in different codes for different loading conditions are also be comparing..

1.3 STRUCTURAL IDEALIZATION

- The deck structure is placed on four legged jacket, the supports of deck are shown in figure.
- The fixed off shore top side deck plat form generally considered as the dimension is 57x38x18m in X-Z-Y Direction the Y portion is up side.
- The plat form consist of Drilling deck, Flare tower, Utility process module, Accommodation module, Drilling supports.
- The deck structure is the supporting module for the above mentioned components, and the consideration for design is the only deck frame .
- The Top side deck plat form stay on the four legged jacket and supports are considered as

fixed. The structure is 40m height from mean see level. The topside consists of six level deck structure namely Cellar deck at EL (+) 40m, Inter mediate deck at EL(+) 48m, weather deck EL(+) 58m. The modelling of structure by the STAAD Pro V8i,and the dimensions are shown in fig 3.2,3.3.

2. Modeling and Design

In the present study, the fixed offshore deck structure is considered for design and modeled in Staad pro software, the deck plat form is 40m above from MSL, and the total height of deck structure is 18 m. The all deck structure is constructed by the steel structures and the all structural elements are having the same grade of steel Fe410,and the columns are all tubular and the al beam members are I sections. the all structural columns and bracings are considered as the fixed. The whole structural components are joined by nodes and welding, the joints are considered as the rigid type of joints. The components on the deck are not modeled in the project and their loads are considered for design, the joints are considered as rigid. The model is being analyzed by in-place analysis in STAAD Pro v8i software.

3.1 material property of steel

Table.3.1. Shows the material property of steel members.

Yield stress ,(f _y)	250 N/mm ²
Ultimate strength of material,(F _u)	410 N/mm ²
Elastic modulus ,(E)	200000.00 N/mm ²
Poisson's ratio,(μ)	0.3
Density, (ρ)	7850 kg/m ³

Fig.3.1. shows the height of the deck structure from Men Sea Level (MSL)

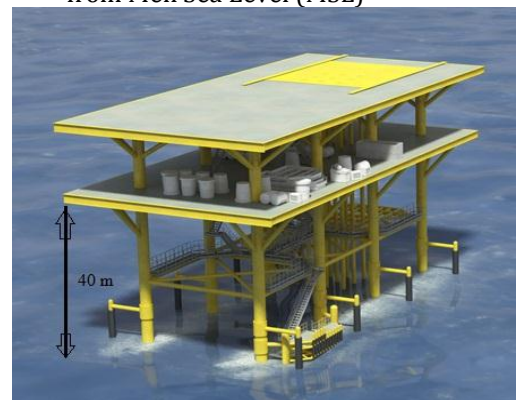


Fig.3.2. shows the dimensions of model of the deck structure.

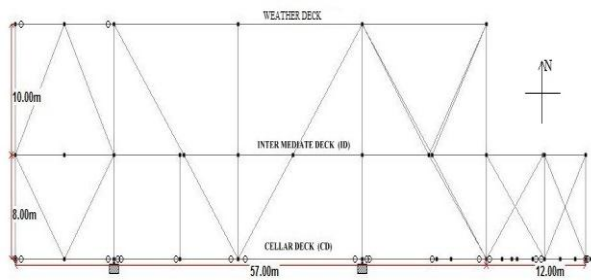


Fig.3.3. shows the dimensions support of deck structure.

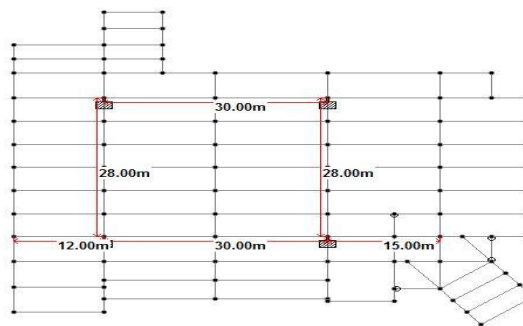
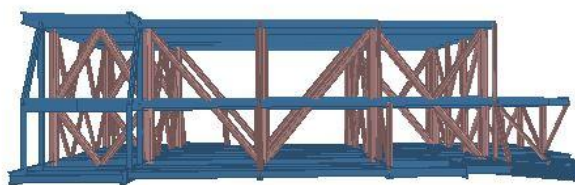


Fig.3.4. shows the 3D view of model.



3.2 Load Cases and Combinations Considered in the Design.

Loads on off shore structures: Adequate strength is ensured by defining design loads scenarios and combinations thereof. Design loads include self-weight, operational loads such as Mechanical/ Equipments loads, Piping, Electrical, Instrumentation and Open area live loads as well as environmental loads due to wind, ice or snow.

The top side structures shall be designed to withstand the maximum loads resulting from combination of loads expected during the different phases of the structures life.

a) VERTICAL LOADS

- Dead Load
- Live Load
- Super imposed Dead Load
- Machinery Load
- Ice and snow loads.

b) LATERAL LOADS

- Wind load.

Load combinations

The load combination as per the offshore design codes.

a) DL+LL

b) DL+LL+EL

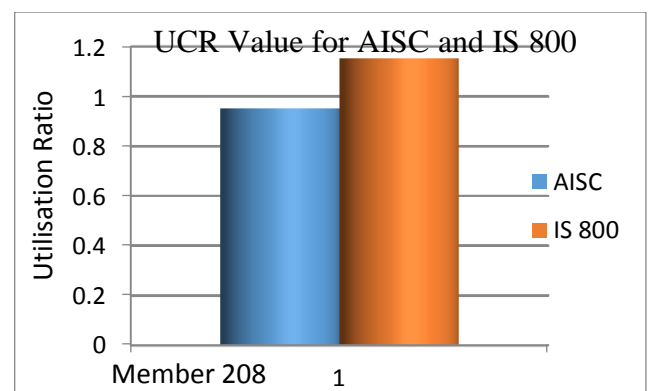
3.3 RESULT AND DISCUSSIONS

A Study of three Dimensional offshore deck frame structure models with IS 8000-2007(LSD) and AISC 360-10(LRFD), with the same loads and load combinations of two codes but design criteria changes as per the two codes and the factors of loads and materials are considered as per the codal provisions. The spread sheet also developed for two codes to validate the staad results. The designed strength of utilization values are compared. The columns are all tubular structures and the beams are all I sections.

3.3.1 The Member strength utilisation ratios results:

The member strength values as per the design of two codes are compared with each other.

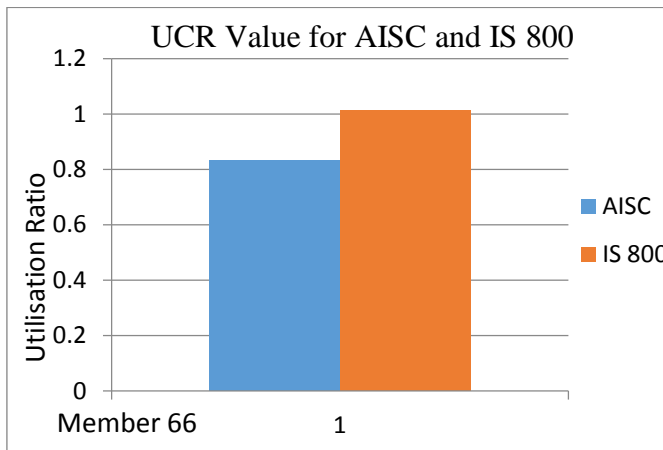
Fig: 3.3.1 show the UCR values for the member 208, tubular section Designed for ULS.



The fig 3.3.1 shows the UCR comparison values for the member 208. the member 208 is an rounded tubular structure, it is used as an column, The member design for the Ultimate limit State (ULS).

3.3.2 Validation of STAAD results with spread sheet design as per codes for both ULS and SLS.

Fig: 3.3.2 show the UCR values for the member 66,I section Designed for ULS.



The fig 3.3.2 shows the UCR comparison values for the member 66. the member 66 is an I section beam member in the structure, it is design for the Ultimate limit State (ULS).

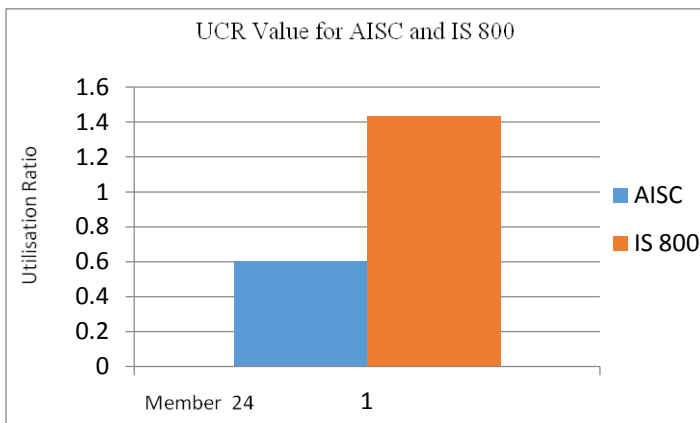
Table 3.3.2.1 Validation of STAAD result with spread sheet design results by IS 800:2007 (LSD)

Member no	UCR as per STTAD	UCR as per Spread Sheet Design
208	1.152	1.119
24	1.436	1.410
120	1.508	1.498
105	1.09	1.11
148	1.654	1.651

Table 3.3.2.2 Validation of STAAD result with spread sheet design results by AISC (LRFD)-360-10

Member no	UCR as per STTAD	UCR as per Spread Sheet Design
208	0.953	0.908
24	0.603	0.6
120	0.674	0.669
105	0.849	0.85
148	0.886	0.9

Fig 3.3.3 show the UCR values for the member 24, I section Designed for SLS



The fig 3.3.3 shows the UCR comparative values for the member 24. the member 24 is an I section beam member in the structure, it is design for the Serviceability or deflection limit State (SLS).

3.3.4 Comparison of Partial Safety Factor (γ_f)

Table - 3.3.4.1 Comparison of partial safety factor for loads (γ_f)

Load combination	Codes	
	IS 800:2007 (LSD)	AISC LRFD-360-10
Dead load+ live load	1.5+1.5	1.3+1.5
Dead load+ live load+ Environmental load	1.2+1.2+0.6	1.3+1.5+1.1
Dead load+ live load+ Environmental load	1.2+1.2+1.2	1.1+1.1+1.3

3.3.4 Comparison of Partial Safety Factor for material (γ_m)

Table -3.3.4.2 Comparison of partial safety factor for material (γ_m)

Definition	Codes		
	IS 800:2007 (LSD)		AISC LRFD-360-10
Resistance governed by yielding/buckling	1.1/1.1		0.9
Resistance governed by ultimate stress	1.25		0.9
Resistance governed by yielding/rupture for tension members	-	-	0.9/0.9
Resistance governed by design compressive members	-	-	0.9
Resistance governed by design flexural/ shear strength members	-	-	0.9/0.9

3. CONCLUSIONS

The thesis attempts to study the comparison of the design criteria and member utilization ration for the fixed offshore deck structure by codes IS 800-2007 (LSD) and AISC (LRFD) 360-10. The project aim to find out the difference of two codes design criteria and the economical design procedure for steel design.

- a) The member strength utilisation ratios obtained based on Limit State or Load Resistance Factor Design based on two codes IS 800:2007& AISC LRFD (360-10) closely compare with each other.
- b) Generalley the utilisation ratio obtained from AISC LRFD (360-10) design are lesser compared to the respective values obtained from IS 800:2007. Referring fig 4.1,4.2,4.3.
- c) The dead load factor used in AISC is the lesser from IS 800. The dead load, being a definitive & known load, use of lesser load factor for DL as in AISC can be justified. Referring table 4.3.
- d) For combinations considering dead, live & Environmental load, IS code have heigher load factors, whereas AISC adopts lesser load factor for live loads. Thus, the floor beams designed based on AISC for gravity loads will be lessser in size compared to Is code. Refring table 4.3.

- e) The codes adopt different load factors for dead load & wind load combinations and AISC adopts a higher load factor for Wind Load. Hence the design of wind sensitive structures based on AISC may govern compared to IS code.
- f) The codes generally adopt the same load factors for the service load combinations and, the IS 800 code adopts the lower value of live load factor in dead, liveand environmental load combination. hence, the deflection computed based on all the two codes will be changed.And the deflection limits of two codes having different values.
- g) STAAD results closely compare with spread sheet design calculations for LSD or LRFD designs as per the codes IS 800:2007& AISC LRFD (360-10). Refring table 4.2.1,4.2.2.
- h) The AISC method of design is the very economical design compared to is-800.And the comparing structure weight and material property.the AISC code is the better to design.

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