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Stress Analysis of IPS Support Frame

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1. Introduction

Fig. 1 shows the support frame which consists of a two leg structure of 250 mm x 100 mm box beams with flanged attachments to the existing box beam structure. The 250 mm x 100 mm box beams incorporate circular bolted clamps which support the vertical sections of the pipe covers for the hot and cold leg pipes to the IPS. These clamps form a Y-piece structure which is welded to the IPS support tube. The flanges on the two legs of the support frame are bolted onto pads welded onto the existing 254 mm x 254 mm box beam. The pads form part of the IPS Support Frame. The orientation of the axes is shown in Fig. 2.

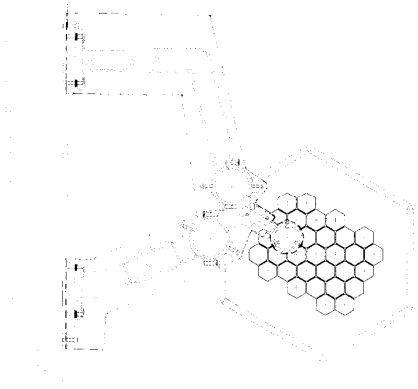

Fig. 1 IPS Support Frame (Plan View) showing Boundary of Class 1 Support

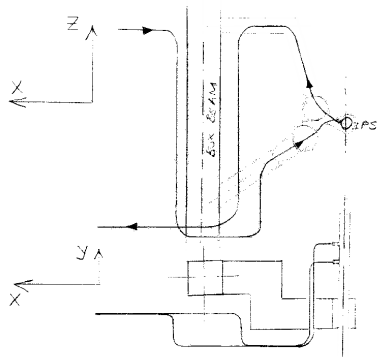

Fig. 2 IPS Support Frame – Orientation of Axes

2. Design Requirements for IPS Support Frame

The principal loadings on the IPS Support Frame are:

- Weight of the IPS Support Frame and IPS
- Seismic loads
- Pipe break loads

In order to simplify the analysis, two enveloping load cases were considered:

- Case 1 where the Service Level B OBE load (assumed identical to the SSE load) were combined with Service Level A loads and the Level C Room 1 pipe break load, with acceptance based on code allowable stresses for Service Level A.

- Case 2, in which the loadings for the Service Level D in-pool pipe break event was combined with Level A loads, with acceptance based on code allowable stresses for Service Level D as defined in ASME III.

Since the SSE load is assumed in Case 1 this case covers the Level D SSE event.

This approach is highly conservative for:

- Service Level A stresses, since Level B and C loads are included
- Service Level B stresses, since Level C loads are included
- Service Level C stresses, since the OBE/SSE load is included
- Service Level D (SSE) stresses, since the Level C load is included

Additionally the approach taken in determining an envelope loading for the in-pool pipe break is considered to incorporate significant conservatism.
The IPS nozzle loads used for the Case 1 analysis are not identical to those determined in the Piping Analysis but incorporate significant conservatism.

3. Stress Analysis Results

The results for the locations with the smallest margins relative to code allowables are given in Tables 1 and 2 below. Reserve Factors, except where stated, are

obtained by dividing the allowable stress by the calculated stress.

Location	Type of Stress	Calculated Stress	Service Level Allowable Stress
Weld connecting right leg end flange to box section	Tensile	28.9 MPa	58.7 Mpa(A) 78.1 Mpa(B) 88.0 Mpa(C) 117.4 Mpa(D)
Screws connecting right leg end flange to box beam pad	Tensile	87.1 MPa	153.0 Mpa(A) 203.4 Mpa(B) 229.5 Mpa(C) 268.9 Mpa(D)
	Combined tensile & shear		
Flange on stiffening rib at right leg end	Tensile bending	41.8 MPa	88.1 MPa(A) 117.2 Mpa(B) 132.1 Mpa(C) 146.9 Mpa(D)
Right leg end flange	Tensile bending	48.5 MPa	88.1 MPa(A) 117.2 Mpa(B) 132.1 Mpa(C) 220.3 Mpa(D)
Screws connecting left leg end flange to box beam pad	Tensile	79.7 MPa$	153.0 MPa(A) 203.4 Mpa(B) 229.5 Mpa(C) 268.9 Mpa(D)
	Combined tensile & shear		
Weld connecting left leg end flange to box section	Tensile bending	18.7 MPa	58.7 MPa(A) 78.1 Mpa(B) 88.0 Mpa(C) 117.4 Mpa(D)
Left leg end flange	Tensile bending	44.4 MPa	88.1 MPa(A) 117.2 Mpa(B) 132.1 Mpa(C) 220.3 Mpa(D)
Left leg end flange upper stiffening rib	Tensile bending	37.7 MPa	88.1 MPa(A) 117.2 Mpa(B) 132.1 Mpa(C) 146.9 Mpa(D)
Screws connecting Y Piece to Left Leg	Tensile	35.2 MPa	153.0 MPa(A) 203.4 Mpa(B) 29.5 Mpa(C) 268.9 Mpa(D)
	Combined tensile & shear		
Weld connecting IPS support tube to Y Piece	Shear	15.2 MPa	58.7 MPa(A) 78.1 Mpa(B) 88.0 Mpa(C) 105.7 Mpa(D)
	Equivalent	31.2 MPa	88.1 MPa(A) 117.2 Mpa(B) 132.1 Mpa(C) 264.2 Mpa(D)

Table. 1 IPS Support Frame Stresses for Case 1 Loads

Location	Type of Stress	Calculated Stress	Service Level D Allowable Stress
Weld connecting right leg end flange to box section	Tensile	24.2 MPa	117.5 MPa
Screws connecting right leg end flange to box beam pad	Tensile	106.6 MPa$	268.9 MPa
	Combined tensile & shear		
Flange on stiffening rib at right leg end	Tensile bending	59.4 MPa	220.3 MPa
Right leg end flange	Tensile bending	54.5 MPa	268.9 MPa
Screws connecting left leg end flange to box beam pad	Tensile		
	Combined tensile & shear	178.8 MPa$	268.9 MPa
Weld connecting left leg end flange to box section	Tensile bending		
Left leg end flange	Tensile bending	54.3 MPa	117.5 MPa
Left leg end flange upper stiffening rib	Tensile bending	99.5 MPa	220.3 MPa
Screws connecting Y Piece to Left Leg	Tensile	84.5 MPa	220.3 MPa
	Combined tensile & shear	39.6 MPa	220.3 MPa
Weld connecting IPS support tube to Y Piece	Shear	40.3 MPa	176.2 MPa
	Equivalent	78.3 MPa	268.9 MPa

Table. 2 IPS Support Frame Stresses for Case 2 Loads

4. Conclusion

Stress results have been presented an allowable stress of IPS support frame at the location. Calculated stress is sufficiently lower than the allowable stress values. All these values are lower than the allowable stress.

As a result, it is regarded that IPS support frame could maintain its structural integrity for the design loadings and service loadings.

REFERENCES

[1] ASME Design Requirements for Structural steel members, Section III NF-3322, 2001

[2] FTL Pool Penetration Stress Analysis Report, HAN-FL-E-074-RX-H005, Rev. A, 2004.

[3] Design Report for Supports (for IPS & Piping), HAN-FL-E-320-RT-R002, Rev. 0, 2005.