

Pipe Stress Analysis

1) Introduction

- Objectives & Definition of Stress Analysis
- Critical Line List
- Information Required for Stress Analysis
- Piping Loads – Static & Dynamic
- Static & Dynamic Analysis
- Forces, Moment & Stress Calculations.
- Requirements of ASME B 31.3 Code – Sustained Loads, Thermal Expansion & Occasional Loads.
- Classification of Loads
- Solutions for Piping Loads.

2) Pipe Span Calculations

- Span limitations based on Stress, Deflection & Natural Frequency.
- Allowable Pipe Span Calculations
- Suggested Pipe Support Spacing
- Pipe Span Reduction Factor for Elbows, Concentrated Loads etc.
- Selection of Supports.
- Location of Supports and Restraints.

3) Flexibility Analysis – Expansion Loops & Expansion Joints

- Concept of Thermal Expansion.
- Providing Flexibility in Piping
- Minimum Leg Required to Absorb Thermal Expansion
- Types of Expansion Loops
- Expansion Loop Sizing for Hot Piping
- Expansion Joints – Types, Application & Selection.
- Bellow Materials, Hydrostatic Test Pressure for Bellows
- Guide Spacing for Expansion Joints.

3) Layout Solutions for Weight, Thermal, Vibration & Wind Loads.

- Causes of Pipe Stress
- Layout Solution for Weight Stress – Continuously Supported & Branch Pipe Allowable Spans
- Solving Concentrated Loads and Reducing Loads on Equipment Nozzles.
- Equipment Nozzle Load Qualifications.
- Layout Solutions for Thermal Load using force & Stress Nomographs for Pump and Vessel Piping.
- Checking Piping Layout in Pipe Racks.
- Checking Piping Layout for Reciprocating Equipment
- Checking Piping Layout for Wind Load.

5) Flexibility Analysis using ASME B 31.3 Code Equations

- Thermal Expansion Stress - S_e and Code Allowable Thermal Displacement Stress Range S_a .
- Stress Range Reduction Factors - f
- Bending & Torsional Stress
- Formal Analysis Requirements
- Inplane & Outplane Bending Moments
- Stress Intensification Factors – SIF
- Calculation of Thermal Expansion Stress.
- Cold Spring.
- Flexibility Analysis using Approximate Methods, M.W.Kellog Charts, ITT Grinnel Charts.

6) Sustained Loads - Internal Pressure & Longitudinal stresses

- Theories of Failure
- Stresses acting in Pipe due to internal Pressure
- Sustained Loads Qualification

7) Occasional Load Stresses

- Wind Load
- Seismic Load
- Water Hammer Load
- Analyzing Vibrating Pipe

IV) CAESAR – II – Static Analysis

- ❖ Introduction
- ❖ Nozzle Thermal Growth Calculations – pumps, vessels, heat exchangers.
- ❖ Basics of Piping Input Spreadsheet.
- ❖ Modelling of Piping elements & Isometrics – Bends, Reducers, Valves, Loops etc.
- ❖ Performing Static Analysis.
- ❖ Modifying Load Cases.
- ❖ Hanger Selection.
- ❖ Set up of Wind Load Cases.
- ❖ Set up of SUS, OPE, EXP, HYD, HGR, & OCC loads.
- ❖ Load Case Editor
- ❖ Viewing Reports
- ❖ Equipment Nozzle Load Qualifications
- ❖ Evaluating API 610 Pump Nozzle Loads
- ❖ Coding technique of Vessel piping includes both piping and vessel coding in Caesar II.
- ❖ Local vessel flexibilities using WRC 297.
- ❖ Including vessel modeling
- ❖ Evaluation of local vessel stresses according to WRC 107
- ❖ Practical Examples – Input, Analysis & Redesign.