ATTACHMENT 2

(MANUAL STRESS ANALYSIS CALCULATION REPORT FOR MANIFOLD AREA)

1.1 Supports of Piping and Line Pipe

The cross-country pipelines are mainly supported on metal pipelines. The material is usually alloy metal, which is chosen based on the fluid to be transported. These pipelines are supported on different forms of supports viz, Metal in RCC supports, Metal frame supports, Small Trusses, etc. If the distance between the supports is maximized, the number of supports required throughout the length of pipeline will reduce. Thus, reducing the total cost of erection.

Supports for piping must be spaced with respect to three considerations:

a) Ability to place a support at some desired location.
b) Keeping sag in the line within limits that will permit drainage.
c) Avoiding excessive bending stresses from the uniform and concentrated loads between supports.

The layout and design of piping and its supporting elements shall be directed toward preventing the following:

(a) Piping stresses.
(b) Leakage at joints.
(c) Excessive thrusts and moments on connected equipment (such as pumps and turbines).
(d) Excessive stresses in the supporting (or restraining) elements.
(e) Resonance with imposed or fluid-induced vibrations.
(f) Excessive interference with thermal expansion and contraction in piping which is otherwise adequately flexible.
(g) Unintentional disengagement of piping from its supports.
(h) Excessive piping sag in piping requiring drainage slope;
(i) Excessive distortion or sag of piping (e.g., thermoplastics) subject to creep under conditions of repeated thermal cycling.
(j) Excessive heat flow, exposing supporting elements to temperature extremes outside their design limits.

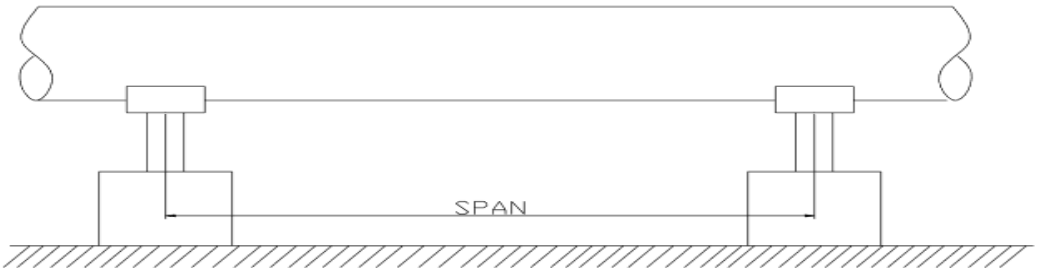

Figure 1. Straight pipe resting on two supports

1.2 Procedure Calculation of Maximum Span Size

Two methods are used in calculating the maximum span size between pipe supports, which are maximum bending stress and maximum deflection theories.

Maximum Bending stress,

$$S_b = \frac{(0.0624wL^2 + 0.1248w_cL)D}{I} \text{ in N/m}^2 \text{ [1]. (1)}$$

Maximum Deflection,

$$y = \frac{5wL^4 + 8w_cL^3}{384EI} \text{ in meter [1].} \quad (2)$$

Where, w = uniformly distributed weight of pipeline in N/m

w_c = concentrated weight on pipeline in N
L = Span length in m
D = Outside diameter of pipe in m
d = Inside diameter of pipe in m
E = Modulus of elasticity of pipe in N/m^2
I = Moment of Inertia of pipe in m^4

Note : Maximum bending stress of the pipe can be taken as 30% of allowable stress.

Design formulas for calculating bending stress and deflection between supports are derived from the usual beam formulas, which depend upon the method of support and the type of loading.

E=203.41 Giga pascal

D = Do = 0.114 m

d = Di = 0.097 m

I = $\pi \frac{D^4 - d^4}{64} = 1.759 \times 10^{-4}\ m4$

S Allowable = 22ksi and $\sigma = 45.48$ mega pascal

Total weight = weight of pipe (Wp) + weight of fluid (Wf)

ρ_{max} = 251.5 Kg/m^3

Wp = 22.32 * 9.81 = 218.9 N/m

$W_f = \frac{(97)\text{^}2 \times 10^{-6} \times \pi}{4} \times 251.5 \times 9.81 = 18.22\ \text{N/m}$

w = 218.9 + 72.45 = 237.12 N/m

A weight of 100 Kg is considered as concentrated weight on pipe between a pair of supports.

Wc = 80*9.81 = 784.8 N

Based on IPS-E-PI-200, the maximum allowable deflection for sloping lines, which is the case for pipeline condition in Gachsaran site, shall be 6.25mm.

Using 2 Equations for defining the maximum span size:

Equation (1)

L_{max} = 15 m

Equation (2)

L = 10 m

The minimum size of span between these two criteria, which is the maximum size of allowable span, is greater than 6 m and It is bigger than what is assumed in the stress file.