Steel piping on saddle supports

Seating of pipes:
Pipes are led by the terrain either freely deposited, on concrete foundations above the terrain, or in the open trenches, and finally buried in trenches. The pipe line is firmly anchored at both ends - one ends is anchored in the foundations of the intake and the other in the foundations of the power house. Apart from these, anchorages are installed at bends and also near the expansion joints of long straight sections. Pipes in these places are equipped with ring girders make of rolled sections. Axial forces acting upon pipes are taken up by the anchors. The pipe is axially fixed to the blocks. Since the piping in these blocks is axially trapped, a dilatation piece must always be inserted between the two blocks to allow dilatation of the pipe at temperature changes. Between the anchor blocks the pipe is supported by concrete piers which take up reactions acting perpendicularly to the axis of the pipe and they permit shifting in axial direction.
Pipes without supporting rigid hoops can be considered tubular continuous beam, placed loosely on a row of supports.
The bending moment from the transverse forces from the fluid weight components and the actual weight of the pipeline, which is evenly distributed along the length, they are counting with continuous beam, stored on the support blocks.
The expansion joint must be placed between two supports that must be sufficiently close to the expansion joint, in order to prevent the pipe from deflecting, which could compromise the correct operation of the expansion joint. The common mode of support is shown on fig.1. The distance between the support blocks is the same. Each length field is loaded with an even load from the fluid weight component and the actual weight of the pipe.

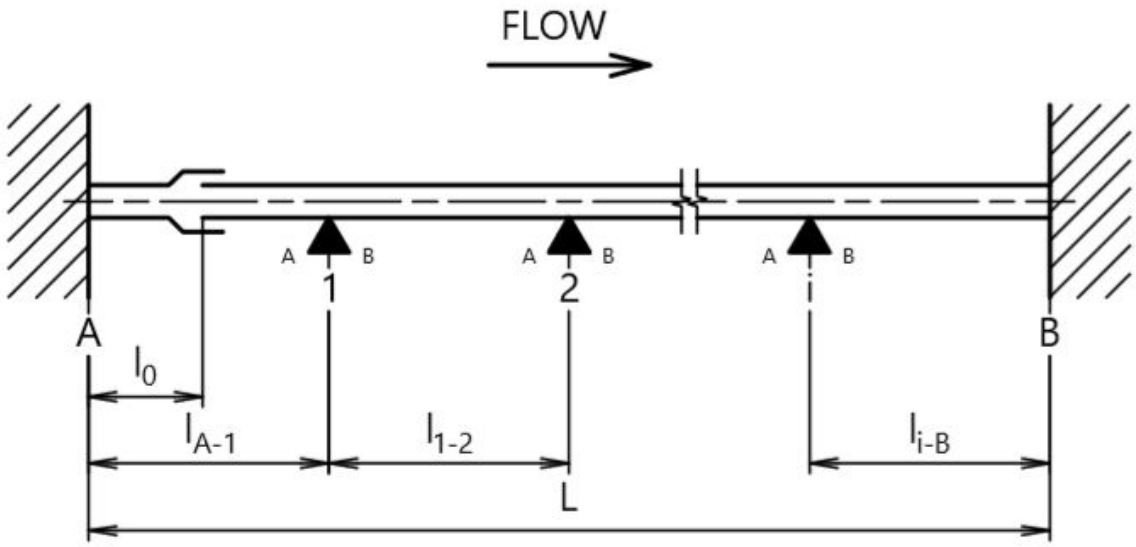

Fig. 1 Steel piping on saddle supports

The force on the first support (from uniform loads the fluid weight and weight of the pipeline):

$$F_{1a} = q_{A-1} * (l_{A-1} - l_0) + 0{,}5 * q_{1-2} * l_{1-2}$$

F_{1a} the force on the first support [kN]

q_{A-1}	uniform load on length A-1	[kN/m]
l_{A-1}	length of section A-1	[m]
l_0	length to dilatation joint	[m]
q_{1-2}	uniform load on length 1-2	[kN/m]
l_{1-2}	length of section 1-2	[m]

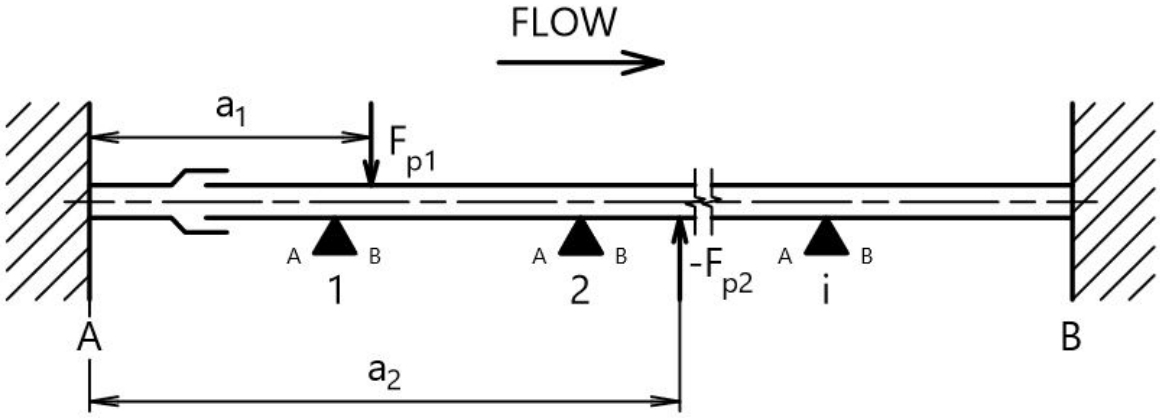

Fig. 2 Steel piping on saddle supports (load of the pipeline by force)

The force on the first support (load of the pipeline by force) from the side of the expansion joint:

The force acts from the first support to the expansion joint.

$$F_{1b} = F_1$$

F_{1b}	the force on the first support	[kN]
F_1	load of the pipeline by force	[kN]

The force on the second support (from uniform loads the fluid weight and weight of the pipeline):

$$F_{2a} = 0{,}5 * (q_{1-2} * l_{1-2} + q_{2-3} * l_{2-3})$$

F_{2a}	the force on the second support	[kN]
q_{1-2}	uniform load on length 1-2	[kN/m]
l_{1-2}	length of section 1-2	[m]
q_{2-3}	uniform load on length 2-3	[kN/m]
l_{2-3}	length of section 2-3	[m]

The force on the first support (load of the pipeline by force):

The force acts on the length l_{1-2}.

$$F_{1c} = F_2 \frac{(l_{A-1} + l_{1-2} - a_2)}{l_{1-2}}$$

F_{1c}	the force on the first support	[kN]
F_2	load of the pipeline by force	[kN]
l_{A-1}	length of section A-1	[m]
l_{1-2}	length of section 1-2	[m]
a_2	distance of force F_2 from the beginning	[m]

Moment in the seat position on the first support from the side of the expansion joint (from uniform loads the fluid weight and weight of the pipeline):

$$M_{1a} = \frac{q_{A-1} * (l_{A-1} - l_0)^2}{2}$$

M_{1a}	moment in the seat position on the first support	[kNm]
q_{A-1}	uniform load on length A-1	[kN/m]
l_{A-1}	length of section A-1	[m]
l_0	length to dilatation joint	[m]

Moment in the seat position on the first support from the pipeline side (from uniform loads the fluid weight and weight of the pipeline):

$$M_{1b} = \frac{q_{1-2} * {l_{1-2}}^2}{8}$$

M_{1b}	moment in the seat position on the first support	[kNm]
q_{1-2}	uniform load on length 1-2	[kN/m]
l_{1-2}	length of section 1-2	[m]

Moment in the seat position on the first support from the side of the expansion joint (load of the pipeline by force):

The force acts from the first support to the expansion joint.

$$M_{1c} = F_1 * (l_{A-1} - a_1)$$

M_{1c}	moment in the seat position on the first support	[kNm]
F_1	load of the pipeline by force	[kN]
l_{A-1}	length of section A-1	[m]
a_1	distance of force F_1 from the beginning	[m]

Moment in the seat position on the first support (load of the pipeline by force):

The force acts on the length l_{1-2}.

$$M_{1d} = F_2 * \frac{(l_{A-1} + l_{1-2} - a_2) * (a_2 - l_{A-1})}{l_{1-2}}$$

M_{1d}	moment in the seat position on the first support	[kNm]
F_2	load of the pipeline by force	[kN]
l_{A-1}	length of section A-1	[m]
l_{1-2}	length of section 1-2	[m]
a_2	distance of force F_2 from the beginning	[m]

Literature:

J. Čábelka: Využitie vodnej energie 2. SVTL 1958
ČSN EN 13445-3: Unfired pressure vessels – Part 3: Design.