STATION PIPING STRESS ANALYSIS OF WATER TRANSMISSION SYSTEMS

Goals of Station Piping Stress Modelling

The major purposes of station piping stress analysis are as follows:

1) Calculate support and restraint forces in order to provide the required information for the civil design
2) Calculate the stress in the piping system in order to confirm that the stresses on pipes and fittings are within the code allowances
3) Calculate stresses on nozzles of pumps, tanks and surge vessels in order to check whether they comply with the allowable values.

The design of every station piping system (as a part of a water transmission or distribution system) is created by taking into consideration multiple stress loads.

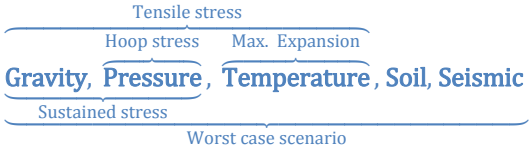
Under any potential stress condition, a safe operation of the piping system must be guaranteed at the best possible cost-safety ratio, which is called optimized design.

The stress analysis is based upon hydraulic parameters, which predefines the design pressure. The extent of the stress conditions is strongly site-dependent. Differences in Temperature or Seismic activity for example may exert excessive forces and/or moments on nozzles of pumps, tanks and surge vessels.

Thus, the piping system has to be analyzed carefully to find the optimal design and to ensure a safe operation at any time. For this purpose, the software AutoPIPE from Bentley Systems is used.

What are the main important aspects to consider in the static design?

Loads & Stress: There are five different external loads exerting stress on the piping system: Gravity (**G**), Pressure (**P**), Temperature (**T**), Soil (**S**) in form of dead loads as well as live loads in case of traffic and seismic activity (**E** for earthquake).



Decisive for the design is the worst case scenario, which consists of sustained stress, hoop stress, maximum expansion and tensile stress as a combination of the previous mentioned stresses, as well as soil and other loads like seismic activity.

The stress ratio (effective stress occurring in the model versus stress allowed by the code) has always to be less or equal to 1, for every load combination, in order to guarantee for a safe operation.

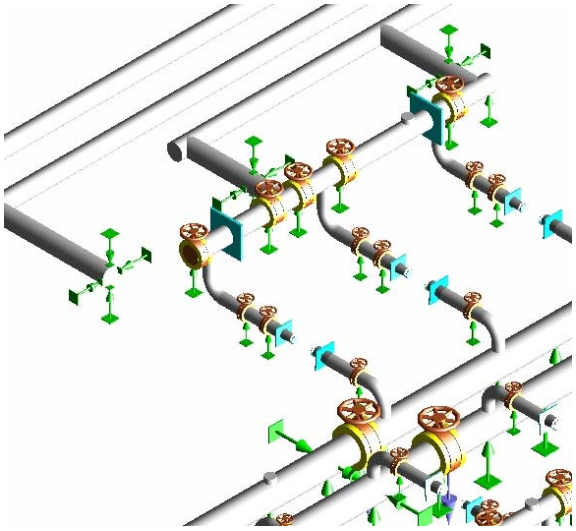
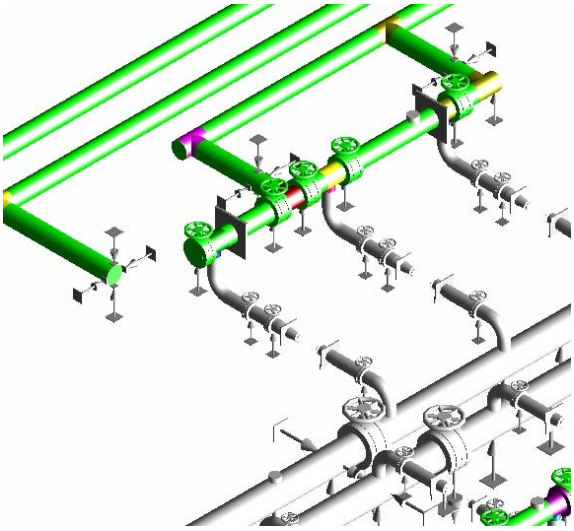
Earthquakes: Seismic activity is added to the model in order to consider earthquakes. Therefore, a reasonable and site-dependent value for peak ground acceleration (PGA) has to be chosen wisely to properly represent the seismic hazard in the investigated area.

Eight different static earthquake loads are specified as a factor of g (gravitational constant). Accordingly to seismic guidelines, one horizontal and one vertical loading, e.g. +/-X and +/- Z as well as +/-Y and +/- Z are combined at a time (where Z is the vertical axis).

Optimized Design: An optimally designed pipeline system is as flexible as possible and as stiff as necessary. Having the least possible number of supports and reinforcements, the optimally designed pipeline system can bear forces and moments exerted on it.

How IBG/HOLINGER can help?

Thanks to a wide experience in stress modelling by using one of the most advanced stress analysis software (AutoPIPE from Bentley Systems), IBG/HOLINGER is able to offer support for the stress analysis and the design of pipeline systems in all kinds of load conditions. In particular, we are able to implement site-specific PGA values to consider local seismic activity at station piping. For example to calculate, evaluate and design nozzle forces (on pumps, tanks and vessels). We can provide the best solution in terms of safe operation and optimized cost-benefit ratio.

Piping System:	Pipe Properties:
	
Stress Ratio:	**Displacements:**