

Stress Analysis of GRP/GRE/FRP piping system using CAESAR II

GRP products being proprietary the choice of component sizes, fittings and material types are limited depending on the supplier. Potential GRP vendors need to be identified early in design stage to determine possible limitations of component availability. The mechanical properties and design parameters varies from vendor to vendor. So it is utmost important that before you proceed for stress analysis of such systems you must finalize the GRP/FRP/GRE vendor. Several parameters (Fig. 1) for stress analysis have to be taken from vendor.

Stress analysis of GRP piping system is governed by ISO 14692 part 3. The GRP material being orthotropic the stress values in axial as well as hoop direction need to be considered during analysis. The following article will provide a guideline for stress analysis of GRP piping system in a very simple format.

Before you open the input spreadsheet of CAESAR II communicate with the vendor through mail and collect the following parameters as listed in Fig.1.

Parameters Required for GRP/GRE Piping Stress Analysis	
Pipe Diameter	Parameter Values
Pipe Outside Diameter, OD	165.7 mm
Pipe Structural Wall Thickness, tr	12.5 mm
Elbow Data	
Elbow structural wall thickness, ta	38.1 mm
GRE Mechanical Properties	
Elasticity modulus, Ea	17030 MPa
Elasticity modulus, Eh	28131 MPa
Shear modulus, G	11000 MPa
Poisson ratio, $\nu_{hoop/axial}$	0.59
Poisson ratio, $\nu_{axial/hoop}$	0.36
$Ea/Eh \cdot \nu_{hoop/axial}$	0.36
Thermal expansion coefficient, α	15.7×10^{-6} mm/mm/C
Long Term Axial strength at 2:1 stress ratio, $\sigma_{al}(2:1)$	54.9 MPa
Long Term Axial strength at 0:1 stress ratio, $\sigma_{al}(0:1)$	39.3 MPa
Long Term Hoop strength at 2:1 stress ratio, $\sigma_{hl}(2:1)$	109.8 MPa
Qualified Stress for Joints, σ_{qs}	109.8 MPa
Bi - Axial stress ratio for Joints [r]	1
Qualified Stress for Bends, σ_{qs}	109.8 MPa
Bi - Axial stress ratio for Bends [r]	1
Qualified Stress for Tees, σ_{qs}	109.8 MPa
Hoop modulus to the Axial Modulus Ratio, Eh/Ea	1.652
Thermal factor, K	0.85
Design Factors for GRE System	
System Design Factor, f2	0.67 (SUS), 0.83 (OPE), 0.85 (HYD)
System Design Factor, f3	1 (for U/G Pipe)
Partial Factor for Temperature, A1	1 (for Design temperature 75 deg. C)
Partial Factor for Chemical resistance, A2	1
Partial Factor for cyclic service, A3	1 (Static Design)

Fig.1: Parameters required for stress analysis of GRP piping

Grp Piping Pipe Stress Analysis Manual

Michael R. Lindeburg



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