sintra engineers

Compact flange

Assessment of oval compact flange according to EN13445-3 annex B

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Project description

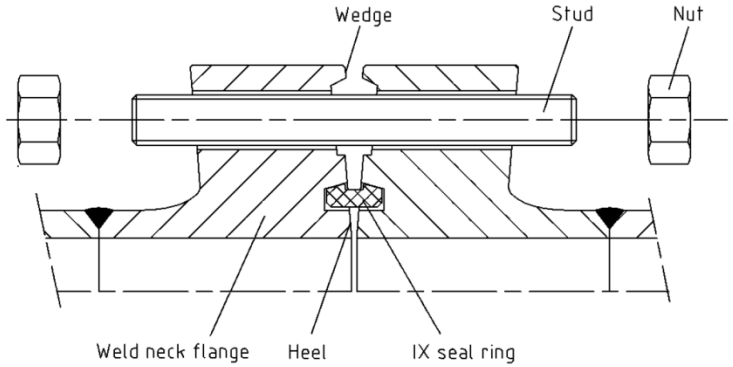
- Design of a compact flange
- Project in cooperation with PLT Pipe Line Technology Netherlands

Principle of compactflange

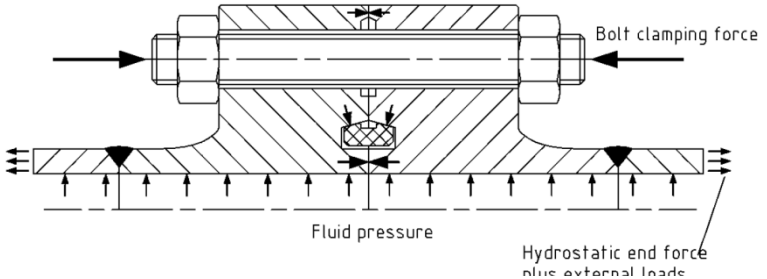
- Contact pressure between heel of both flanges ensures leak tightness
- Seal ring is secondary sealing
- Due to angle of flange face, a high contact pressure is established in sealing surface
- High tolerance for cyclic loading with respect to leak tightness.

Principle of compactflange

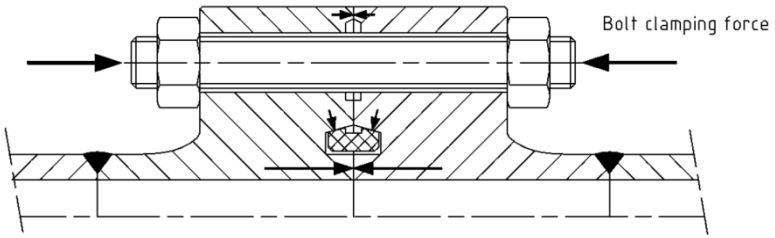
Before assembly



After assembly



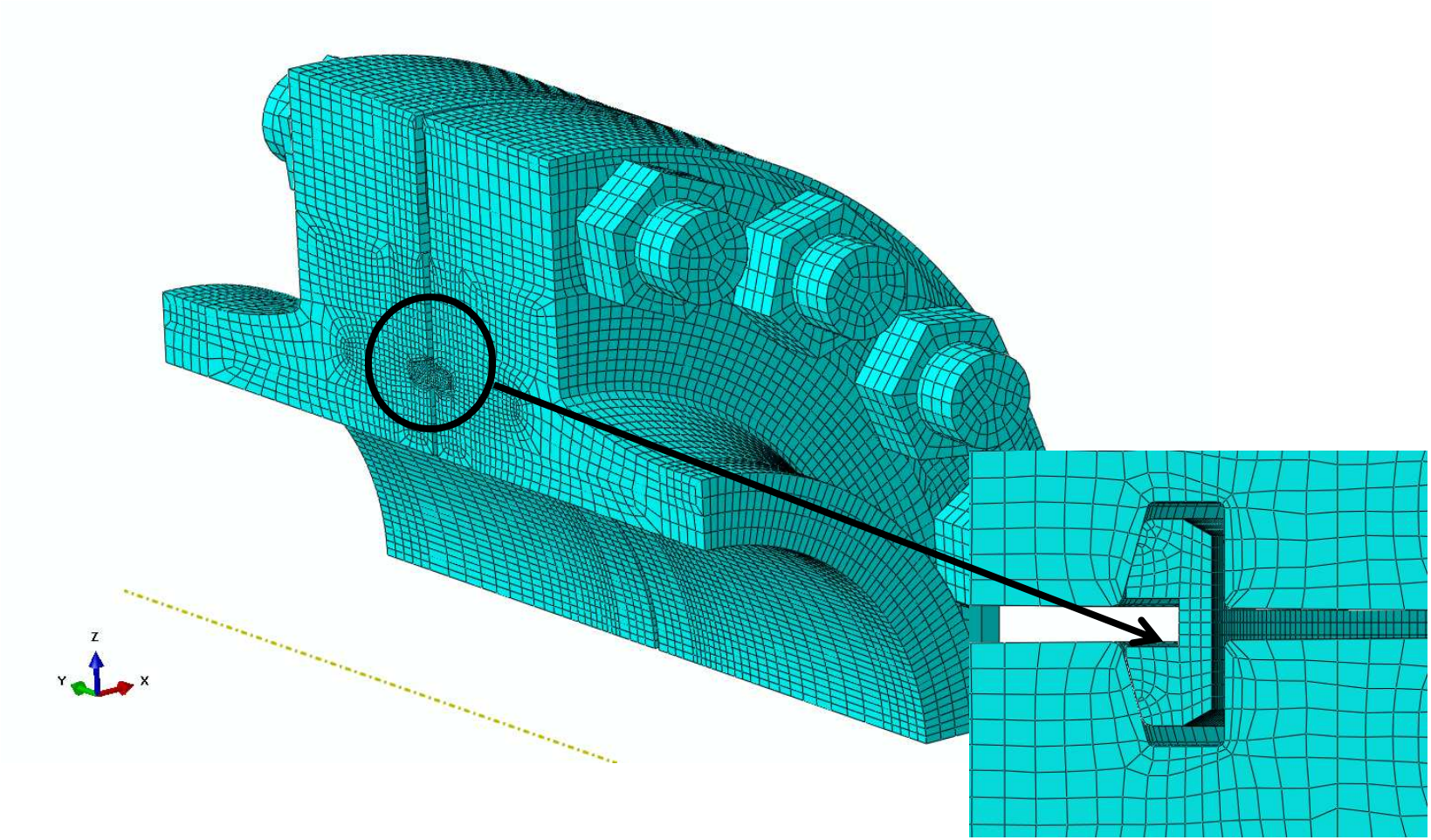
designloads



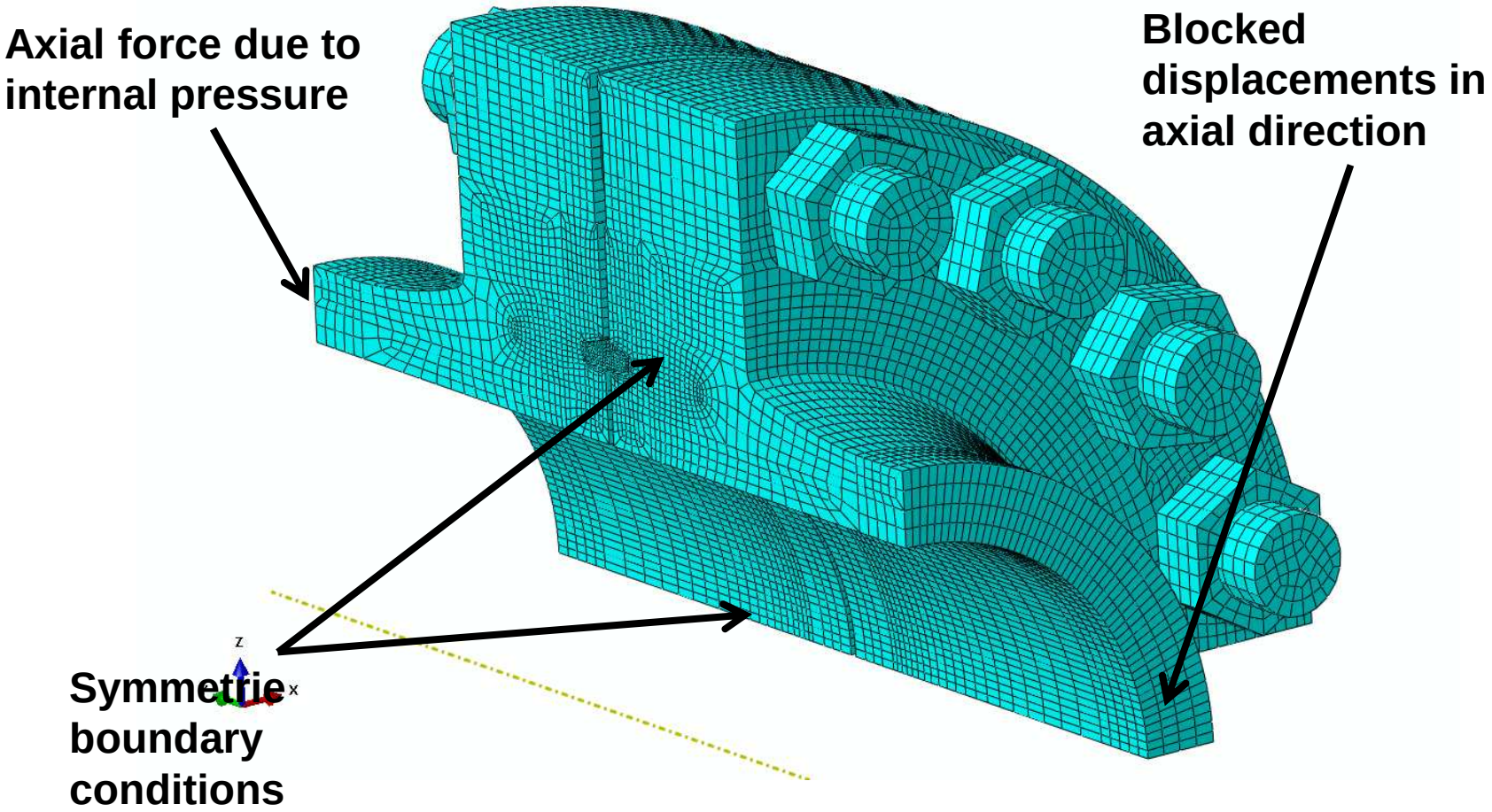
FEA model

- ¼ model of flange
- 1st order brick elements
- Contact between flanges and sealring
- Pretension elements in bolts
- Tie between bolts and flanges

FEA model



Boundary conditions



Loadcases (1)

- According EN13445-3 annex B
  - Gross plastic deformation design check
  - Gross plastic deformation testconditions check
  - Progressive plastic deformation (Shakedown)

Loadcases (2)

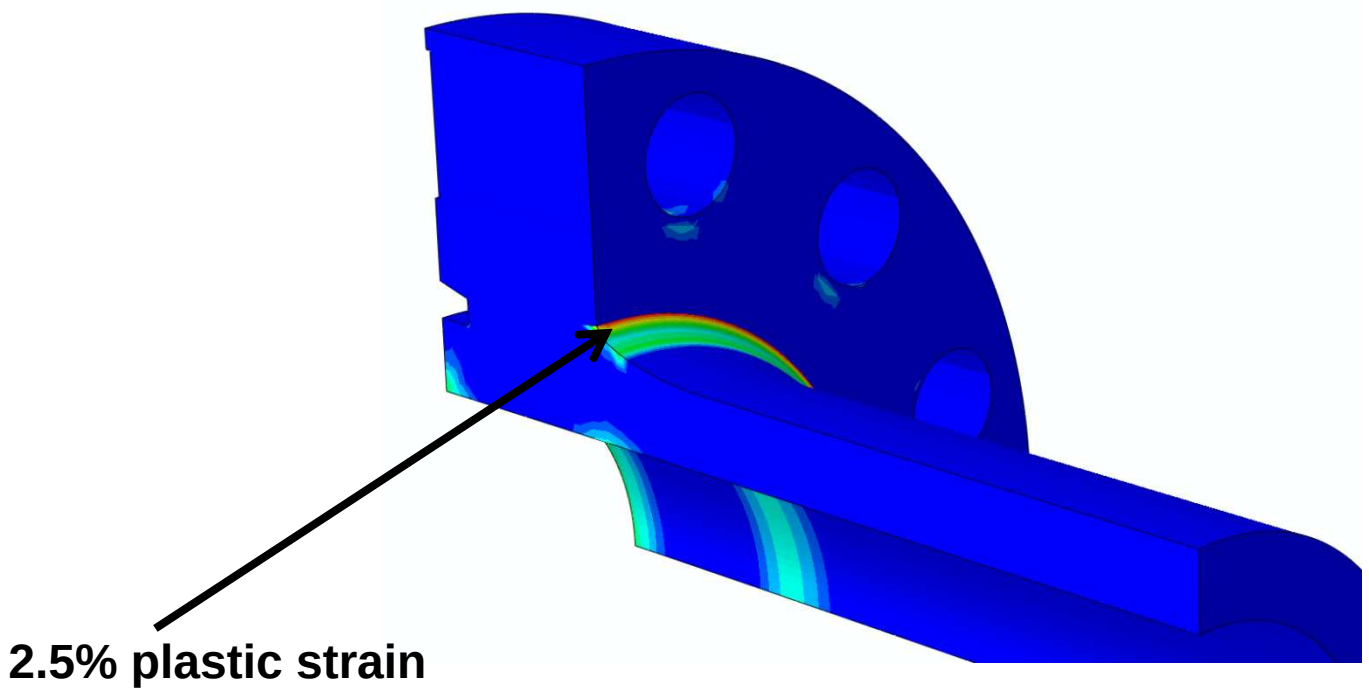
Load case	Load steps	Bolt pretension (per bolt)	Pressure [Barg]	Temp [°C]	External loading from piping system [N]
GPD - DC Design conditions	1	800.000N	-	-	-
	2	Bolt fixed in position	p_{design} x1,2	T_{design}	External loading x1,2
GPD - DC Test conditions	1	800.000N	-	-	-
	2	Bolt fixed in position	p_{test}	-	-
PPD-DC Design conditions	1	800.000N	-	-	-
	2	Bolt fixed in position	p_{design}	T_{design}	External loading
	3		0	0	0
	4		p_{design}	T_{design}	External loading

Assessment

Load case	Assessment criteria
GPD - DC Design conditions	Maximum allowable strain <5% For bolts a maximum of 2% is used
GPD - DC Test conditions	Maximum allowable strain <7% For bolts a maximum of 2% is used
PPD-DC Design conditions	Cumulative maximum 5% strain after 500 cycles For bolts a maximum of 2% is used

Gross plastic deformation design/test case

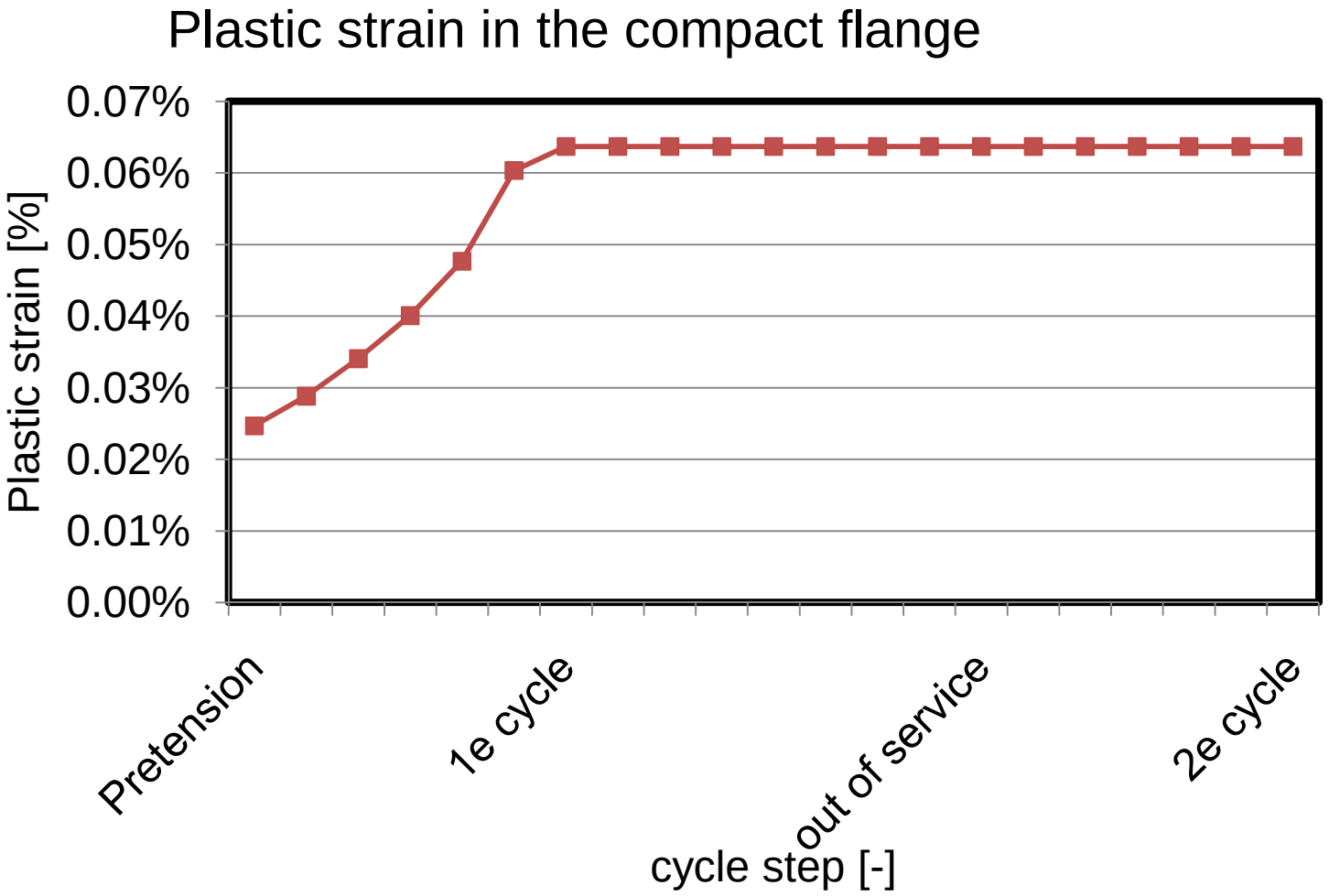
- Maximum plastic deformation is in welding neck area



Progressive plastic deformation (1)

- 5 critical locations:
  - Heel
  - Wedge
  - Neck
  - Bolts
  - Seal
- Goal is to prove that construction shakes down to lineair elastic behaviour.

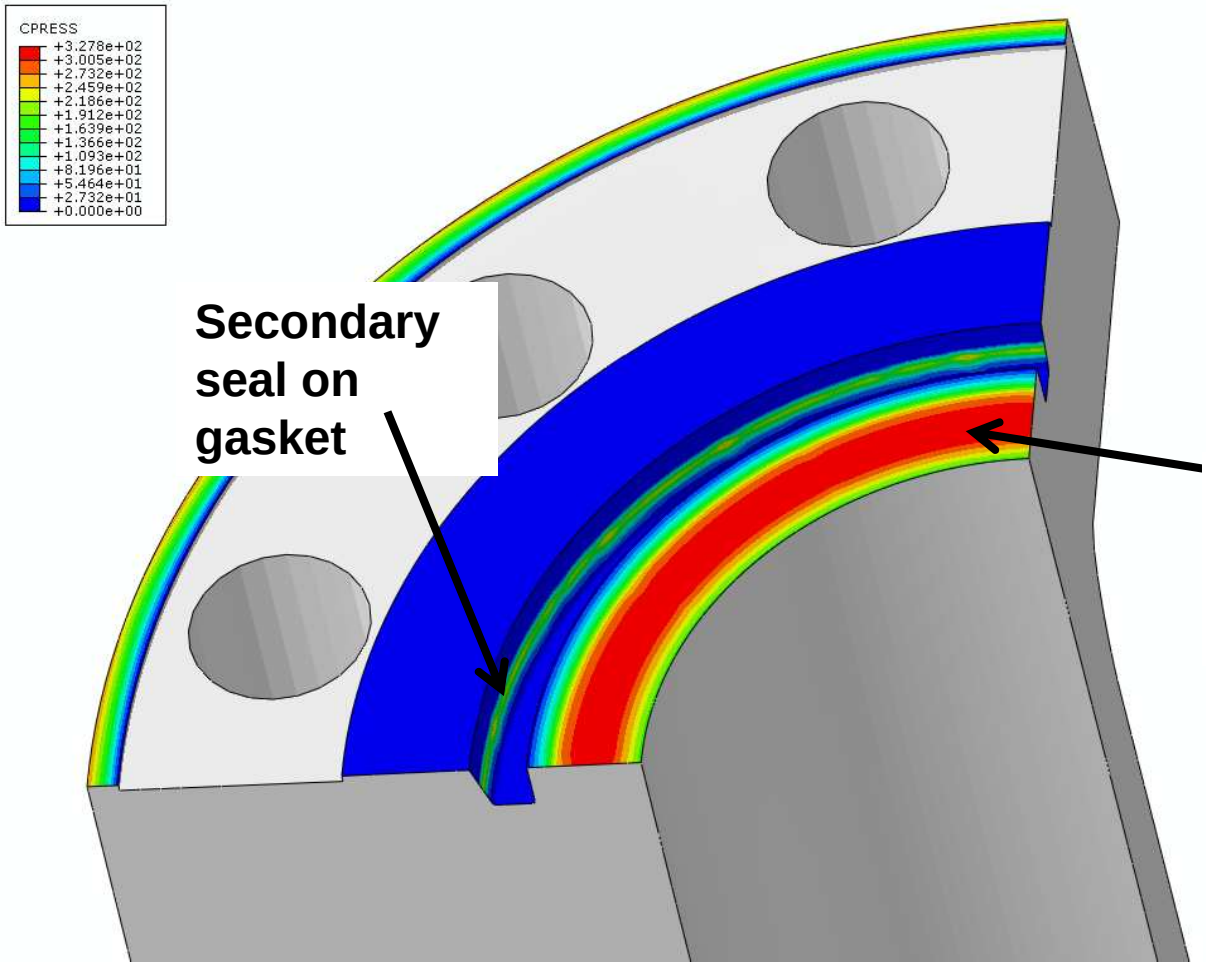
Progressive plastic deformation (2)



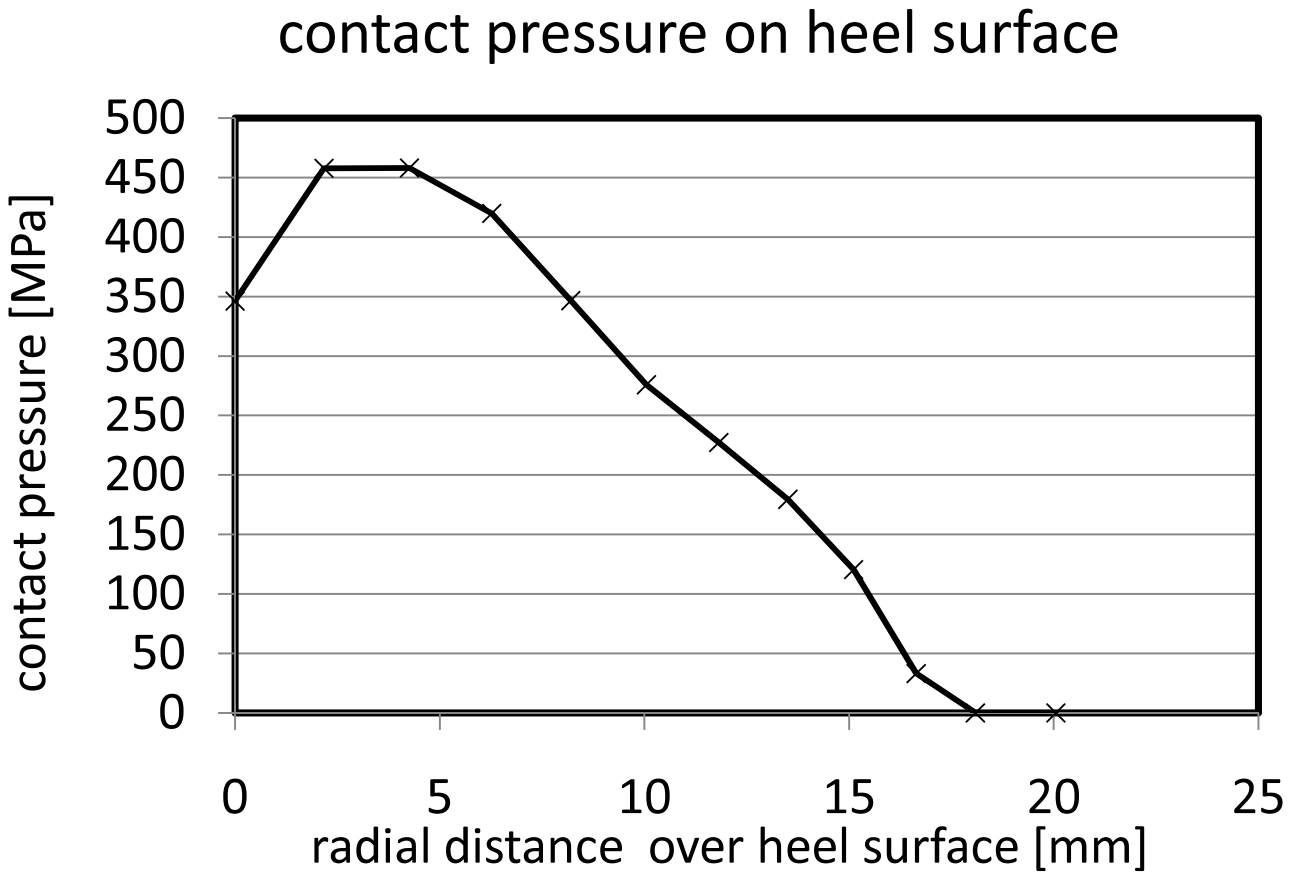
Progressive plastic deformation (3)

- After 1st cycle no additional plastic deformation occures
- Flange connection shakes down to linear elastic behaviour after 1 cycle

Location of assesment of contactpressure



Contact pressure between components



Conclusion

- Plastic strain in design and test conditions are lower than 5%
- Connection shakes down to lineair elastic behaviour
- Contact pressure is always higher then 2x internal pressure, thus sealing is established.