Nguyen Dang Van, Ihn Namgung
KEPCO International Nuclear Graduate School

An Investigation of Wall Thinning and Cross Sectional Geometry Change of Bent Tube of Small Diameters

Objectives

1. To investigate the **deformation profile** of bent tube such as thickening/thinning and **cross-sectional distortion** in cold bending process.

2. The simulation, using FEM tool - ANSYS v.14.5, is used to simulate for any **change of diameter** and **circularity perpendicular to the bending axis.**

3. A **minimum bending radius** of this method should be considered to meet ASME codeôs requirement applying to wall thinning.

Methodology

1. Bending method: **Press bending** was used.

2. Software: ANSYS v. 14.5 workbench and mechanical APDL.

3. The **symmetric model** and press bending method was created. It consists of three rollers and one tube where all contacts were defined to reflect actual contact condition.

4. The stroke of upper roller is defined to produce displacement resulting in required bending radius.

5. Trend of wall thinning, thickening, and ovality will be investigated.

Results and Discussions

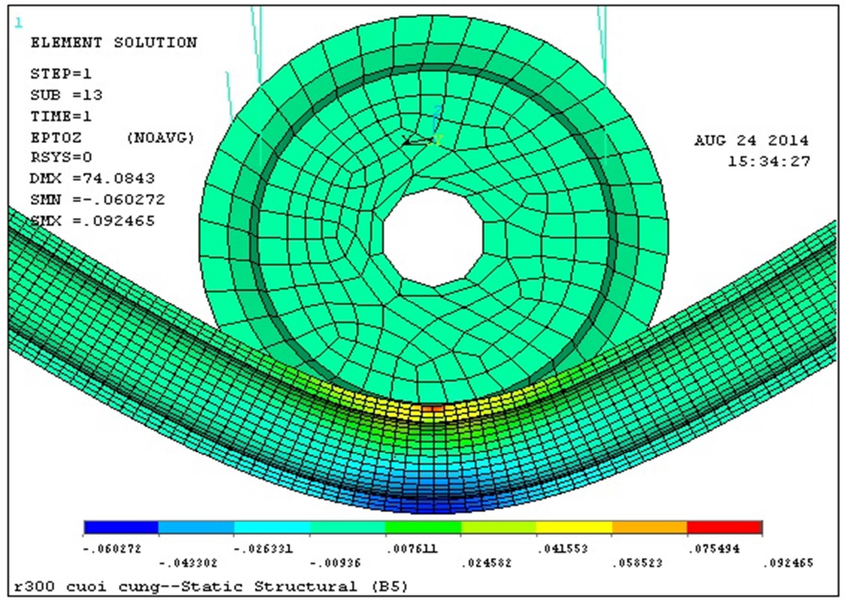

Fig.3. Distribution of total mechanical strain of bent tube wall

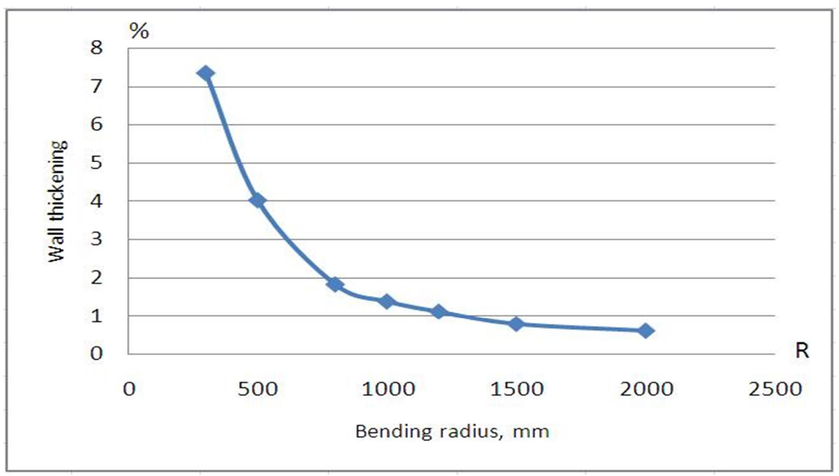

Fig.4. Effect of bending radius for wall thickening of tube for diameter D=33.4mm

- The results indicated that when bending radius increases, the wall thinning and thickening will decease. And if the diameter of tube increases, the wall thickness increases as well.

Nominal Pipe Size, in.	Pipe Outside Diameter, mm	Nominal Wall Thickness, mm SCH. 40S
3/8	17.1	2.31
1/ 2	21.3	2.77
1	33.4	3.38

Table 1. Dimension of three cases of stainless steel pipe ï SI units.

-Austenitic stainless steel F316L was selected which is used in the NPP broadly. The material is assumed to be elastic perfectly plastic, and friction condition is 0.1.

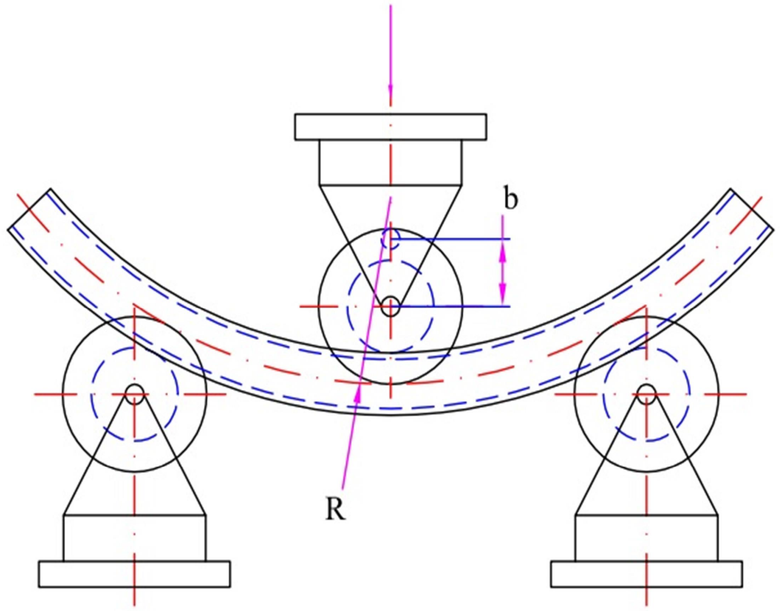

Fig.1. Sketch of the principle of press bending method

- In order to get desired bend radius, tube is placed on two lower rollers, while upper roller moves vertically on the tube causing plastic deformation.

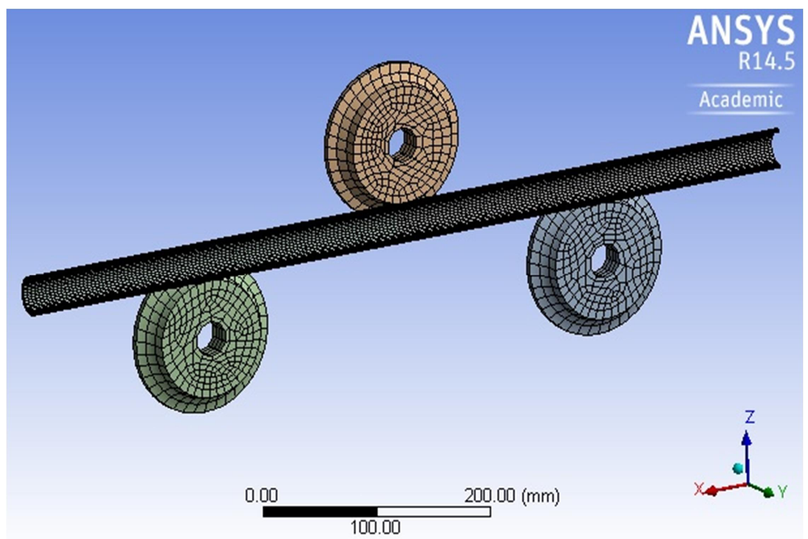

Fig.2. Geometric and meshing of tube bending

- Refinement of mesh was done to get more accurate solution of bending process.

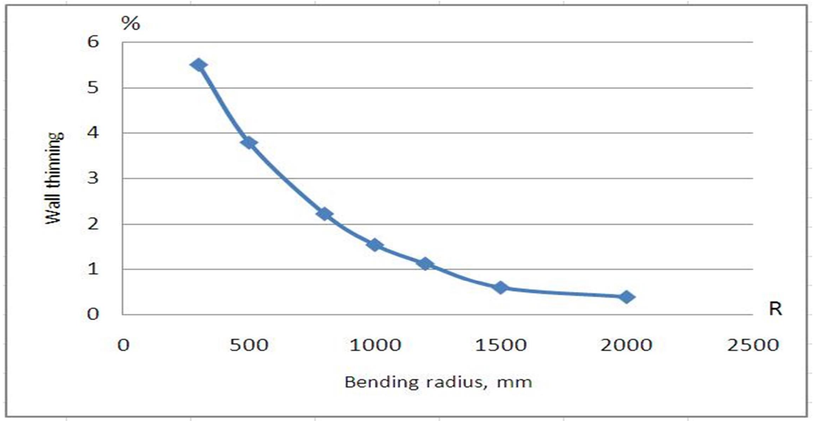

Fig.5. Effect of bending radius for wall thinning of tube for diameter D=33.4mm

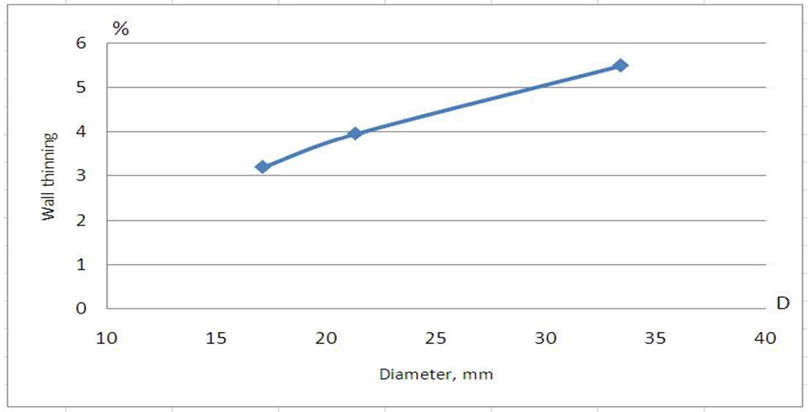

Fig.6. Effect of diameter for wall thinning for bending radius R=300mm

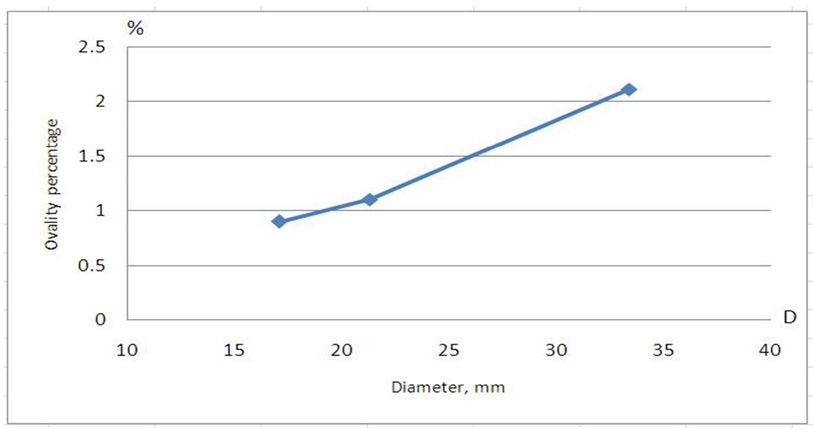

Fig.7. Change of ovality for bending radius R=300mm

Conclusion

- The bend region of tube appears thicker wall at intrados and thinner wall at extrados. Moreover, bending process affects significantly the ovality of tube cross section at bend region.
- This is one of the particular applications where geometric deviations need to be carefully monitored.