THE IMPROVEMENT OF RESIDUAL STRESS FOR LASER CUTTING COIL

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OUTLINE

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- MEASUREMENT AND APPLICATION RESULTS
- ANALYSIS AND IMPROVEMENT
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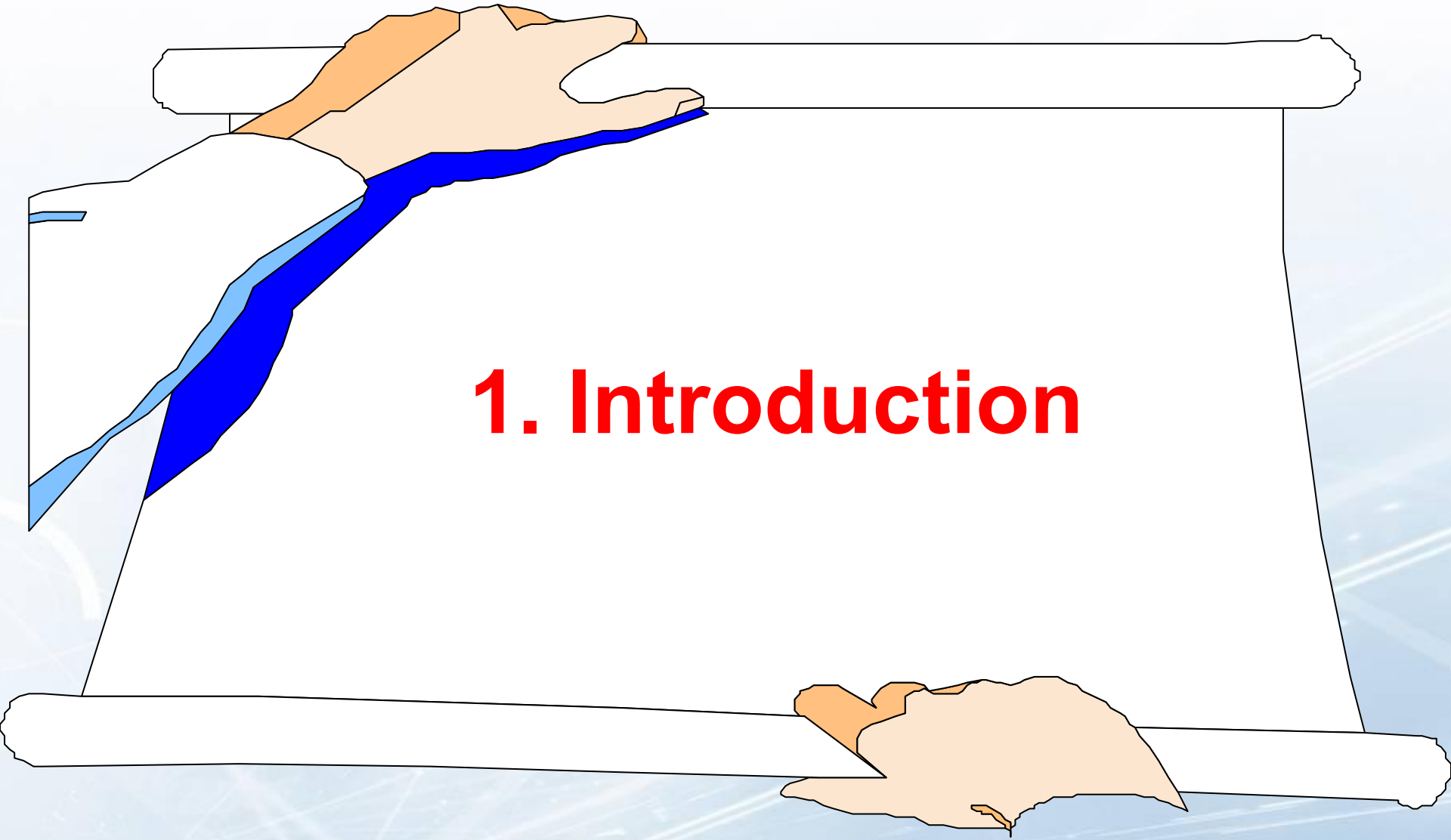
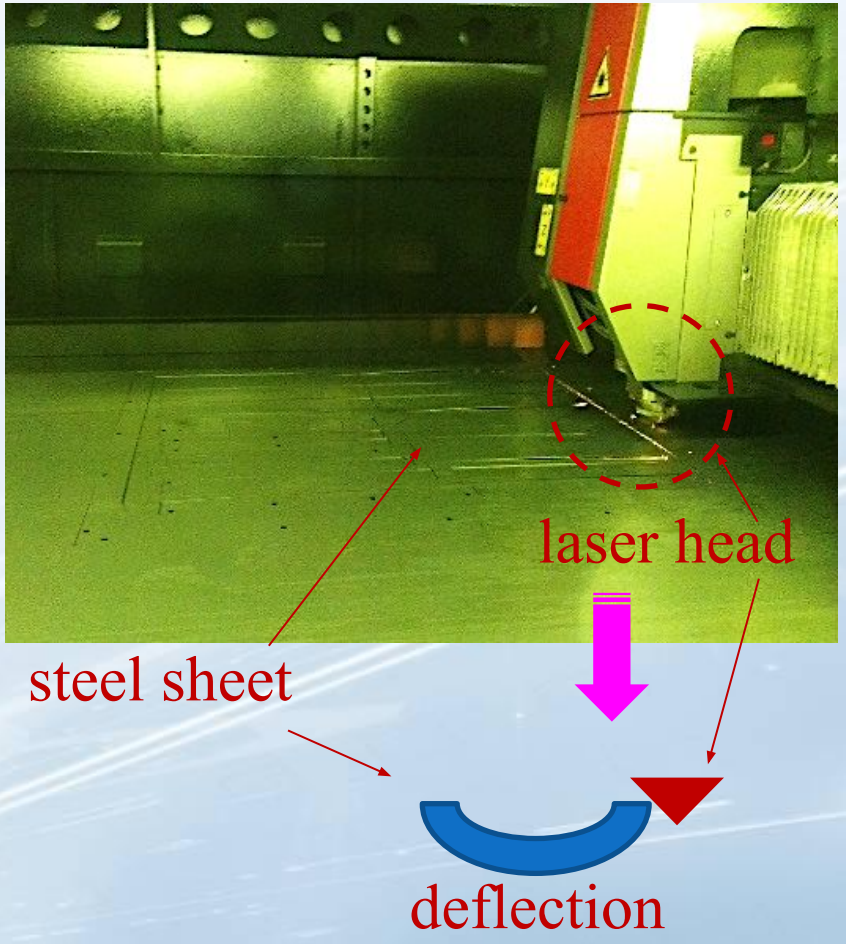


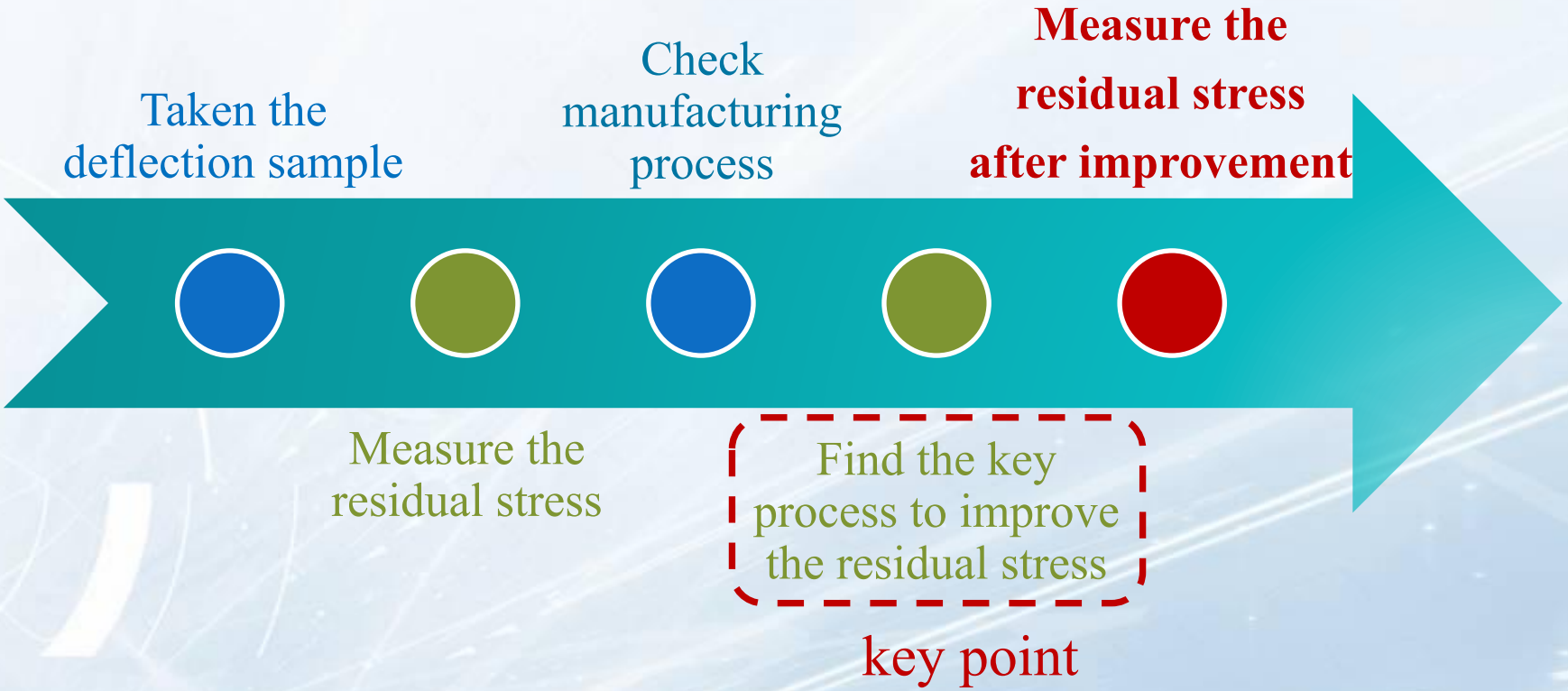
1. Introduction

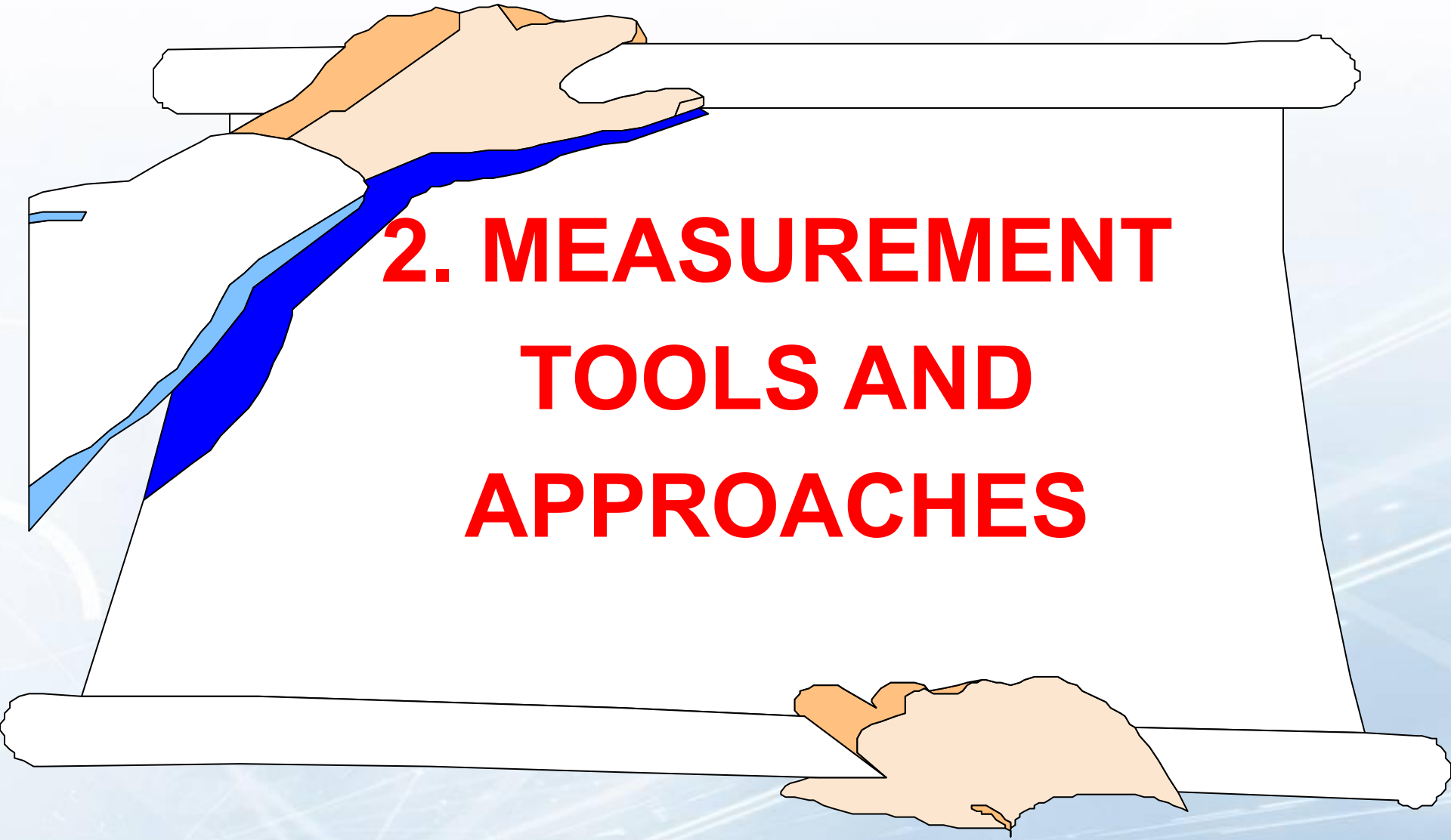
Problem description

- The steel sheet bent up or down ,deflection, when cutting.
- The laser head will be damaged when steel sheet bending up.
- The problem is to solve the deflection issue.
- The key factor is the residual stress.
- How to measure the residual stress?
- What reason makes the residual stress happen?
- How to improve the residual stress in the manufacturing process?



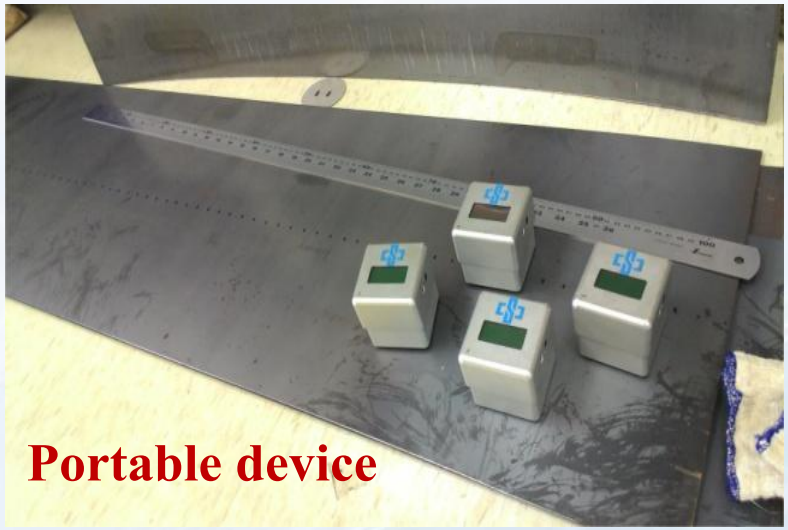
Problem solving process





2. MEASUREMENT TOOLS AND APPROACHES

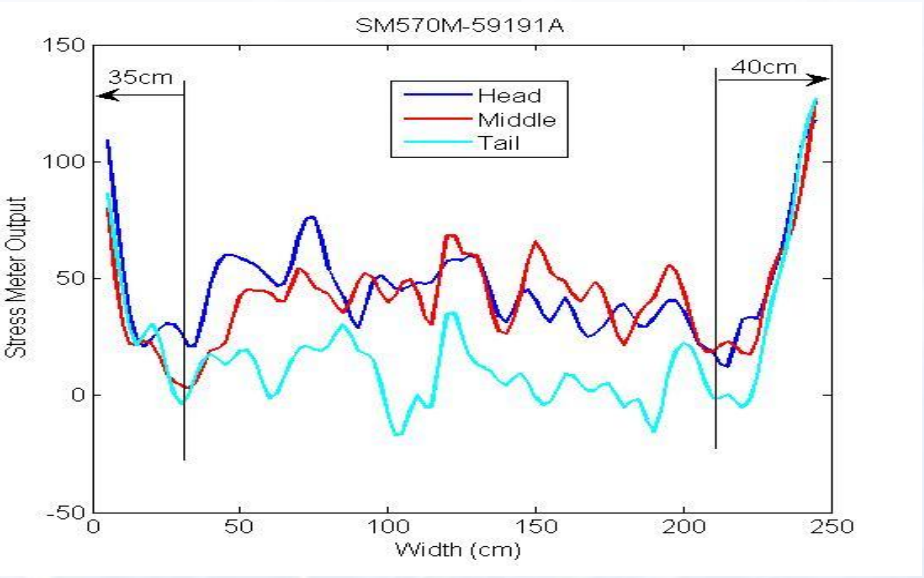
Portable magnetostrictive device

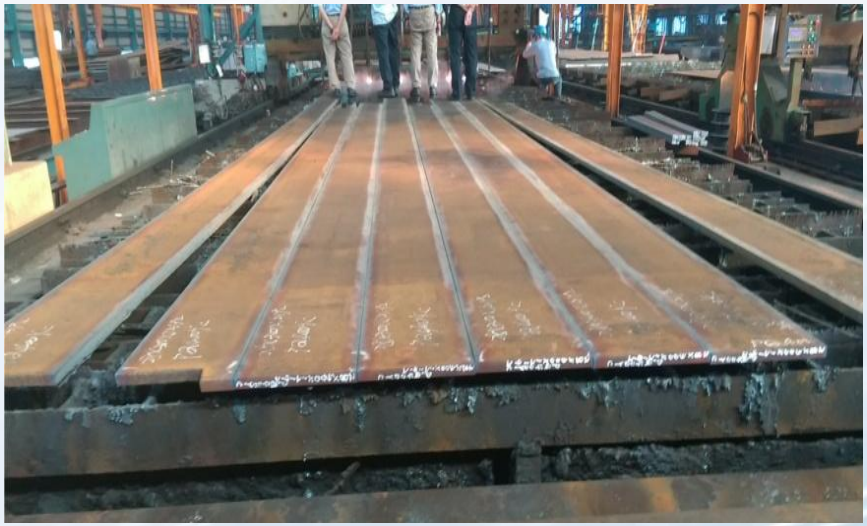


- Non-destructive magnetic sensor
- On-site residual stress measurement
- Mobile device for data storage
- CSC developed this portable device

Ref: S.-K. Kuo, K.-F. Lo, W.-H. Chang, Z.-Y. Syu, “Development of Measurement Technology for Inverse-magnetostrictive Effect of Electrical Steel”, The 39th Symposium on Electrical Power Engineering, Taipei, Taiwan., 2018.

Measurement by magnetostrictive device

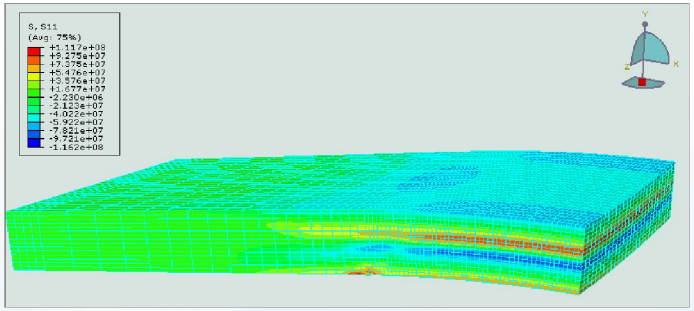


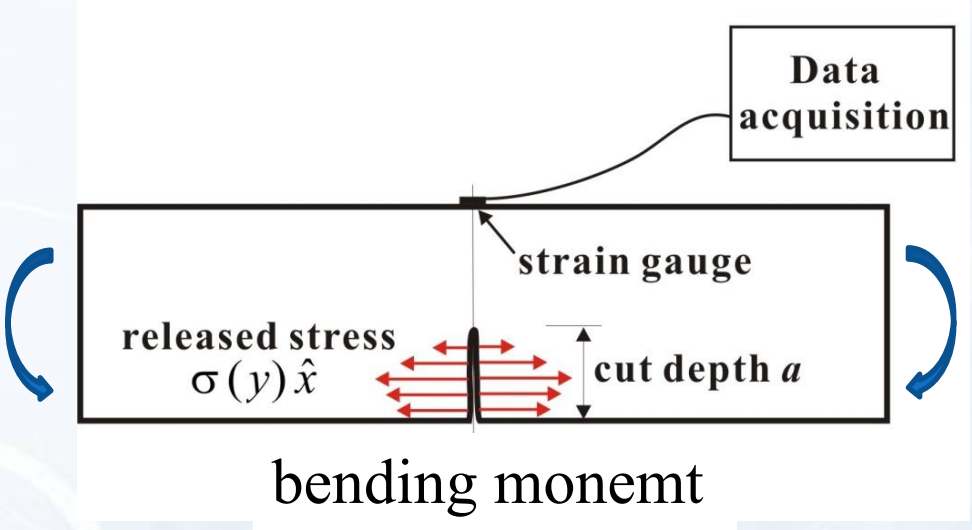


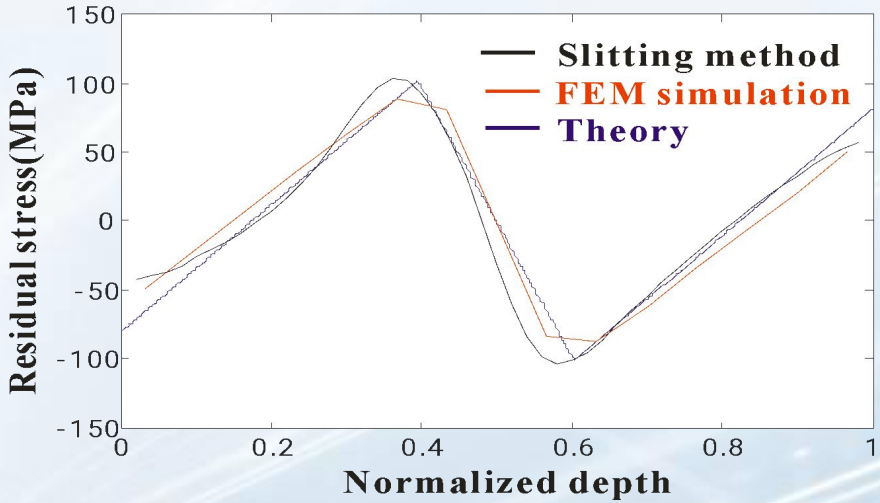
- Measure the width direction of steel plate
- Same feature at 35~40cm from the edge
- Tensile stress is positively related to defflection

Slitting method

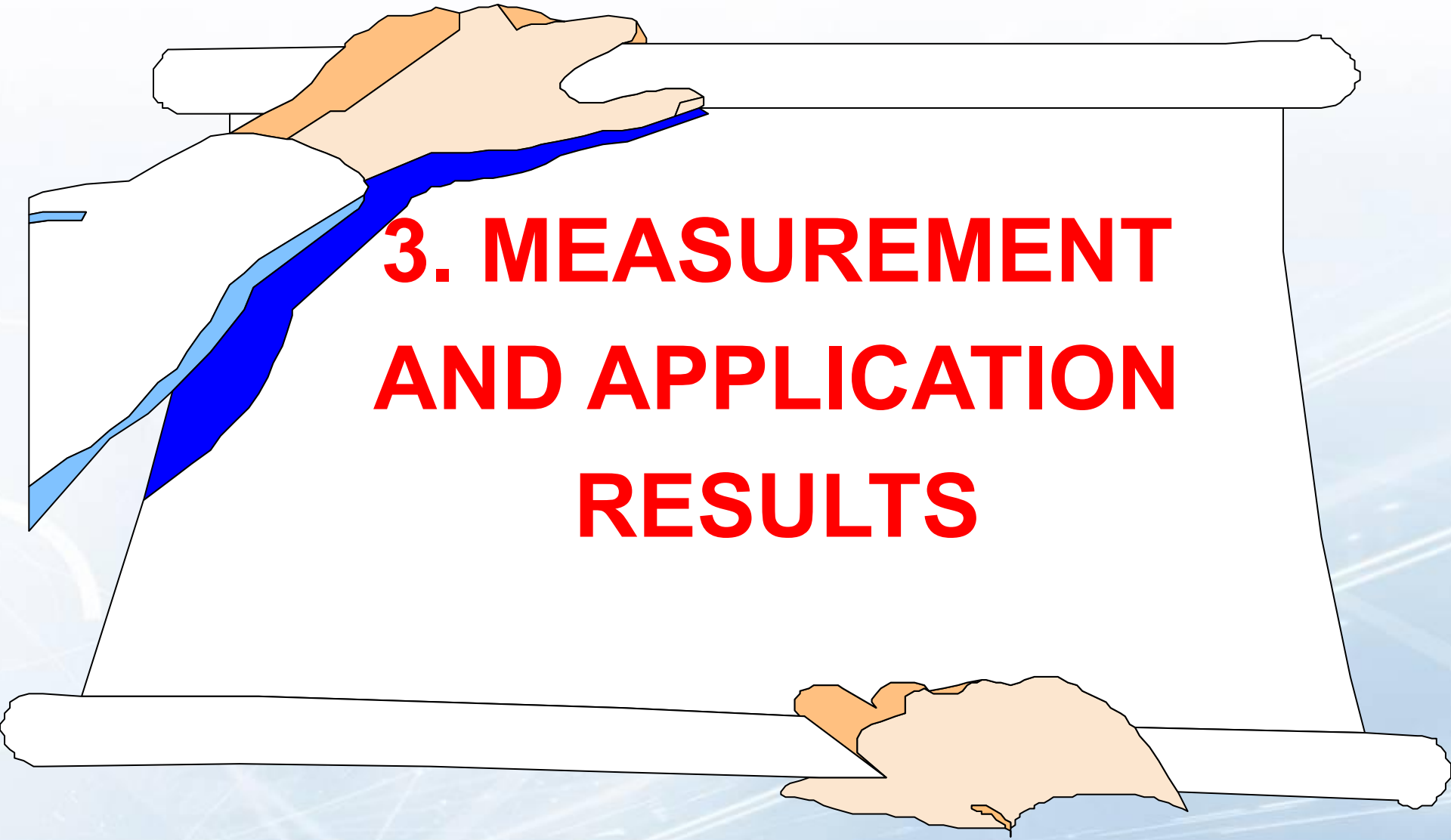
Ref: M. J. Lee “Effect of strain gage-length when determining residual stress by slitting”, Journal of Engineering Materials 2007





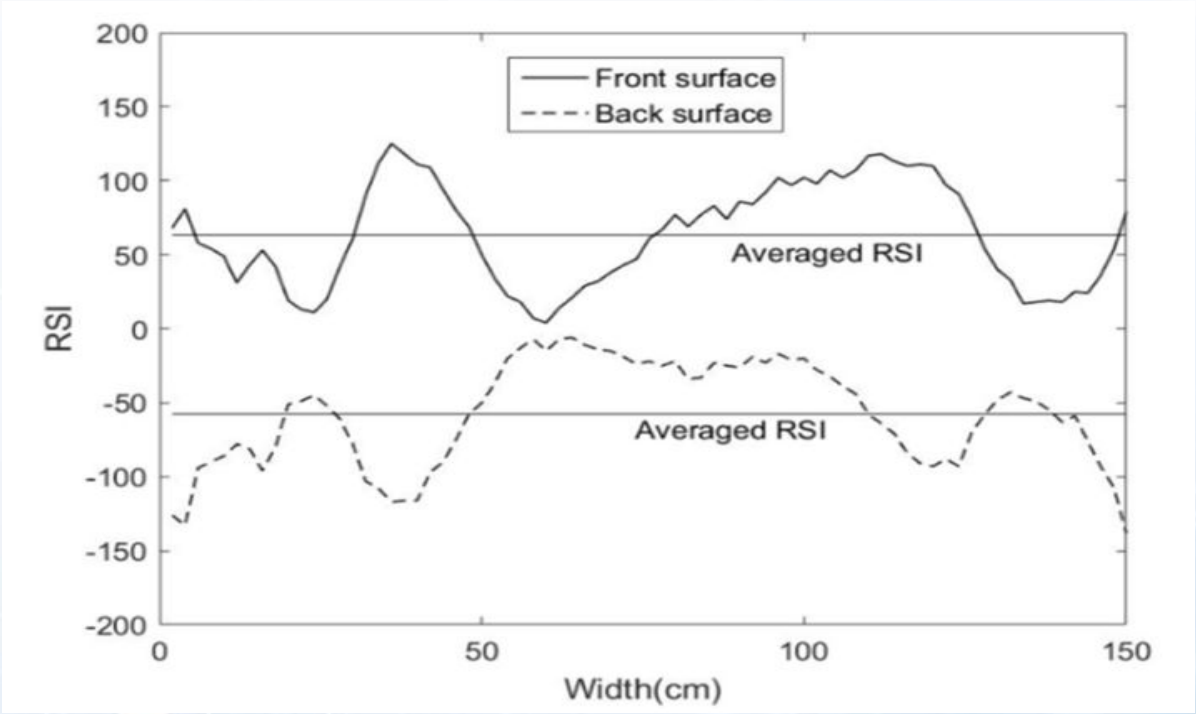


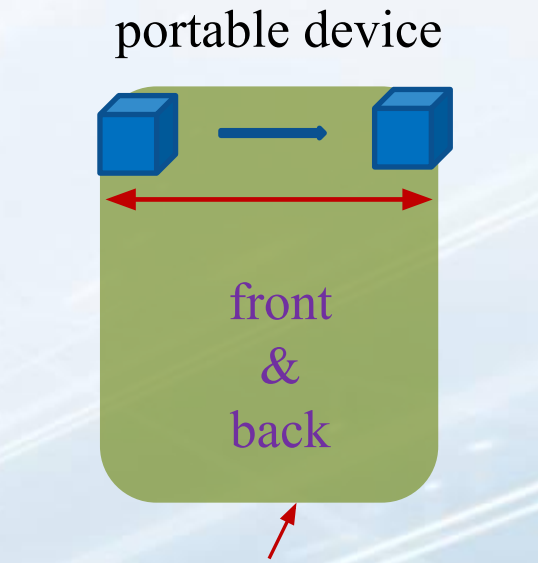
- **Destructive method**
- **Strain gauge is attached to the back of the sample**
- **During the cutting process, the residual stress is released**
- **The residual stress profile has the N type feature when bending moment occurs by three methods**



3. MEASUREMENT AND APPLICATION RESULTS

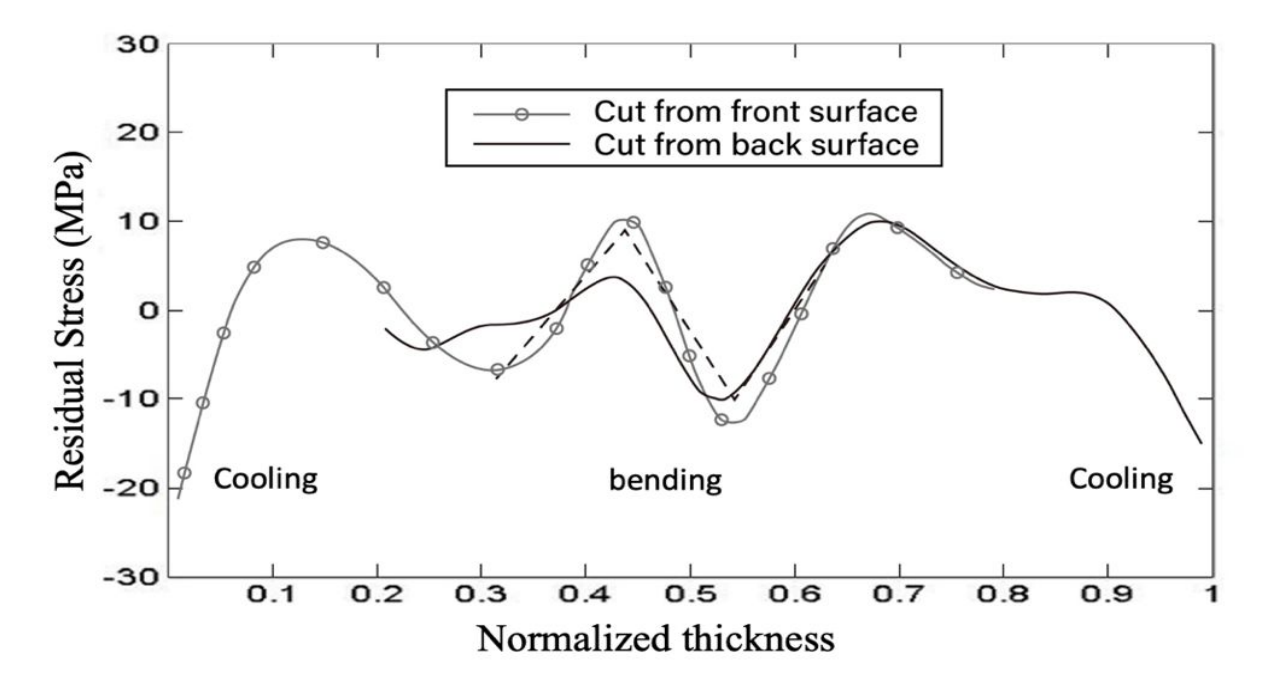
Residual stress measurement

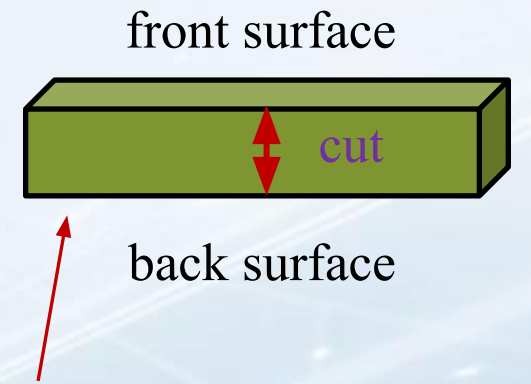




- **Portable magnetostrictive device**
- **Measure the surface along with the width direction of steel sheet**
- **The steel sheet is easy to deflect when cutting**

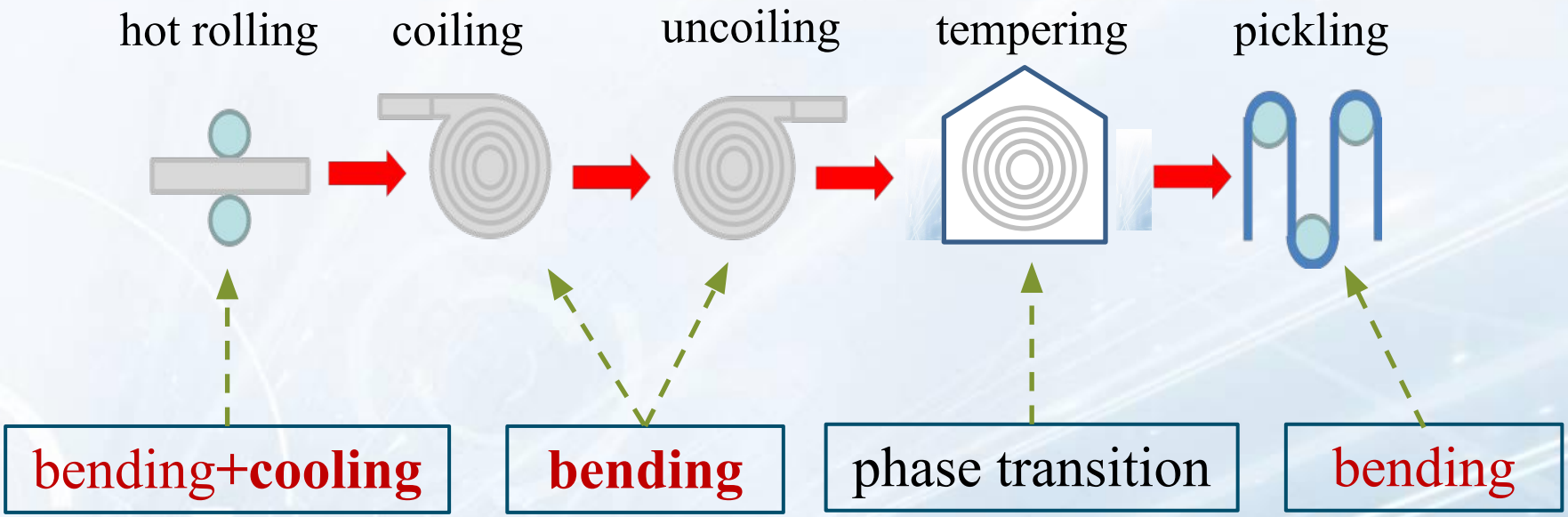
Identify the source of residual stress



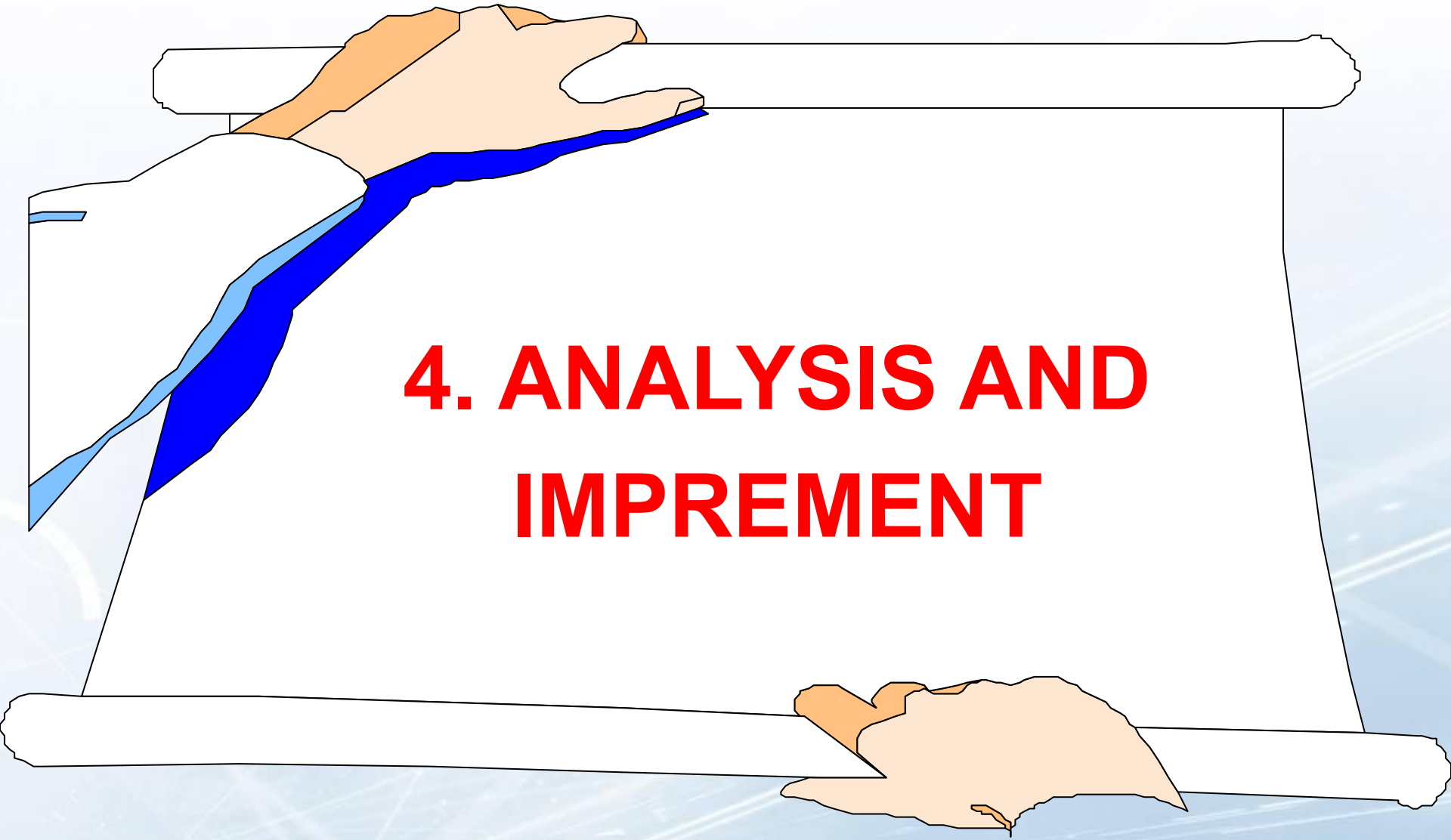


- **Slitting method**
- **Measure the thickness direction of the deflection steel sheet**
- **Compressive stress feature on front and back surfaces**
- **N-type feature in the middle**

Manufacturing process

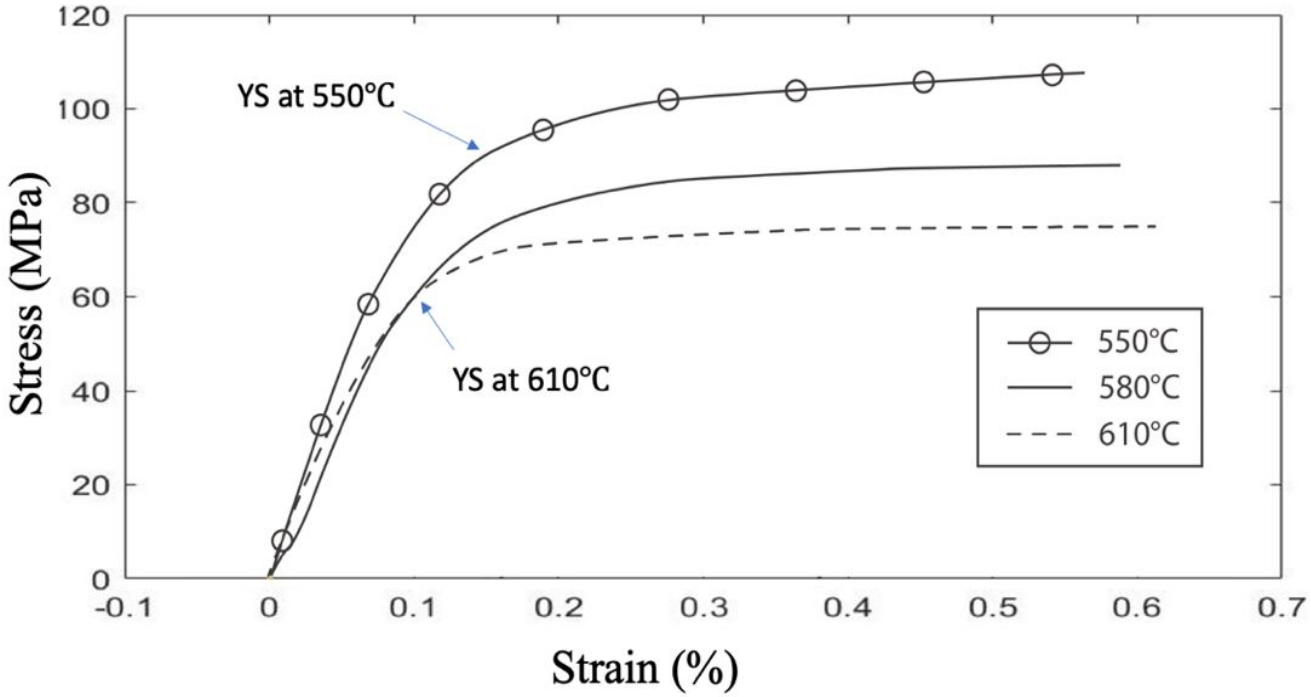


- **Determine which one is the key factor of manufacturing process**
- **Bending shows up 3 times**
- **Try to improve bending by changing coiling temperature**



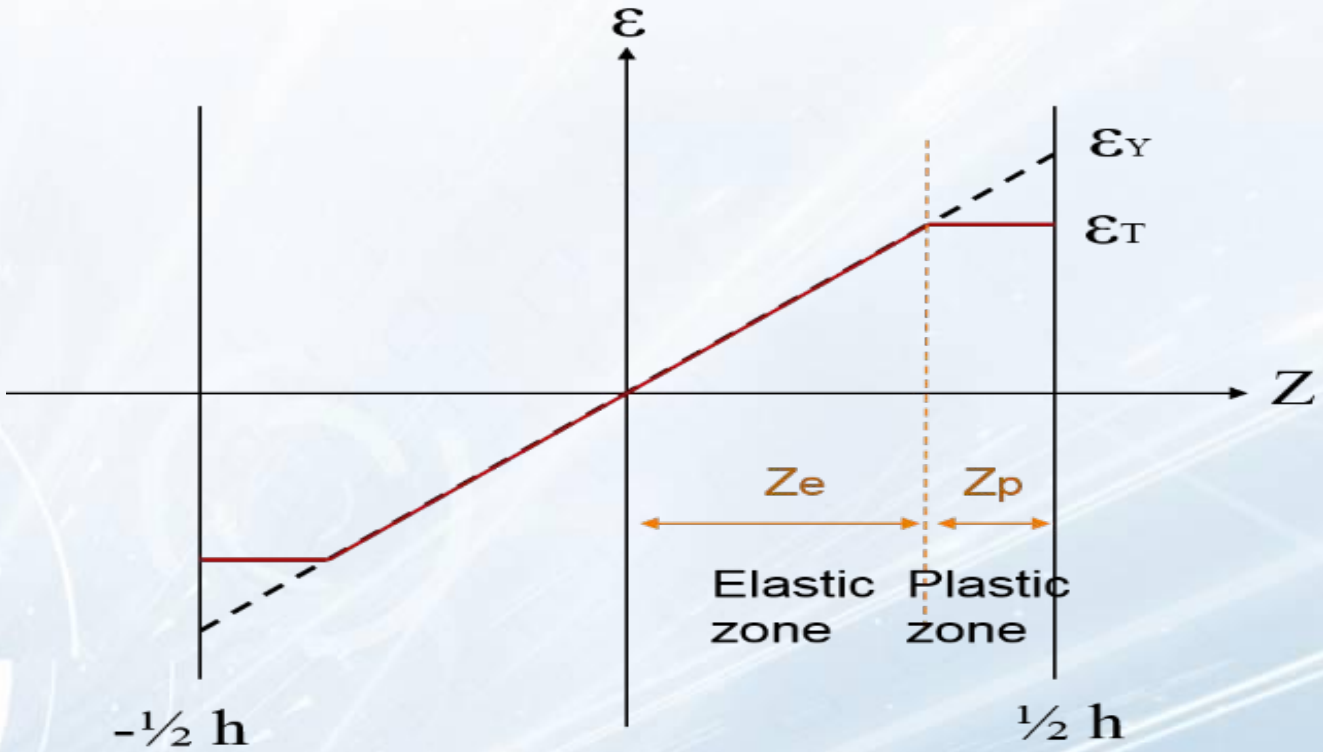
4. ANALYSIS AND IMPREMENT

Changing coiling temperature



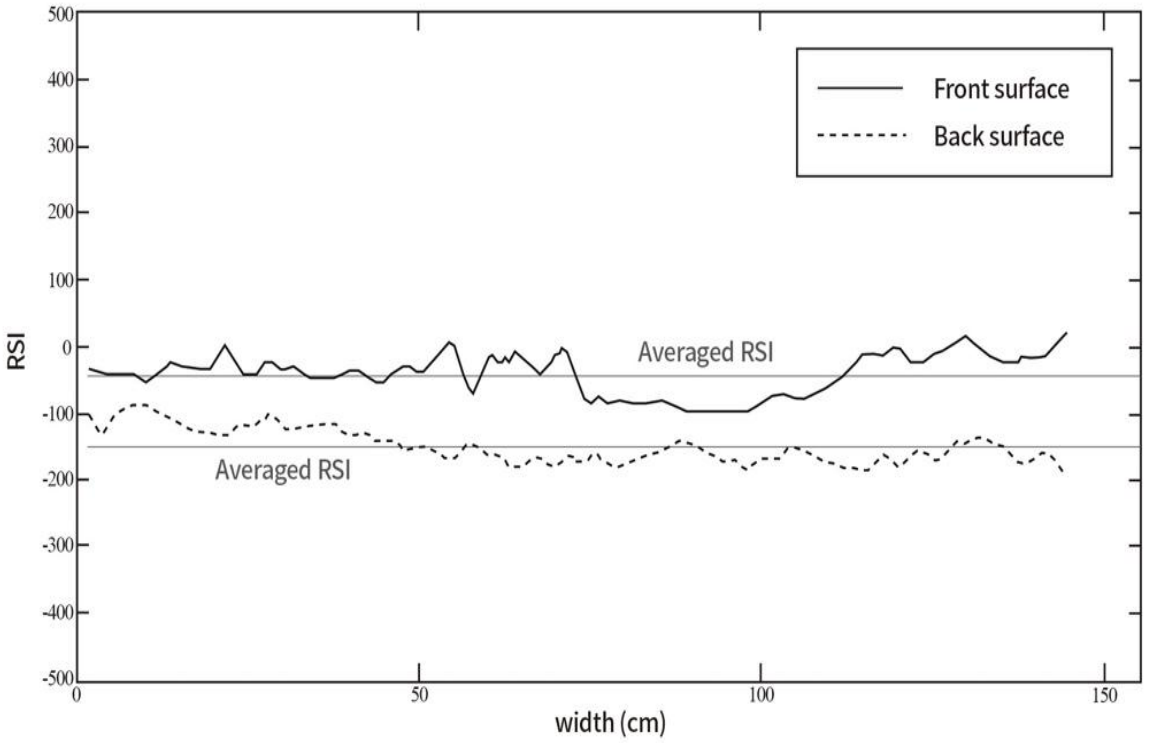
- High-temperature tensile experiments
- The original coiling temperature (CT) is 610℃
- Improve the process by changing CT

Plastic zone calculation



CT	610℃	580℃	550℃
Zp (plastification)	74%	64%	56%

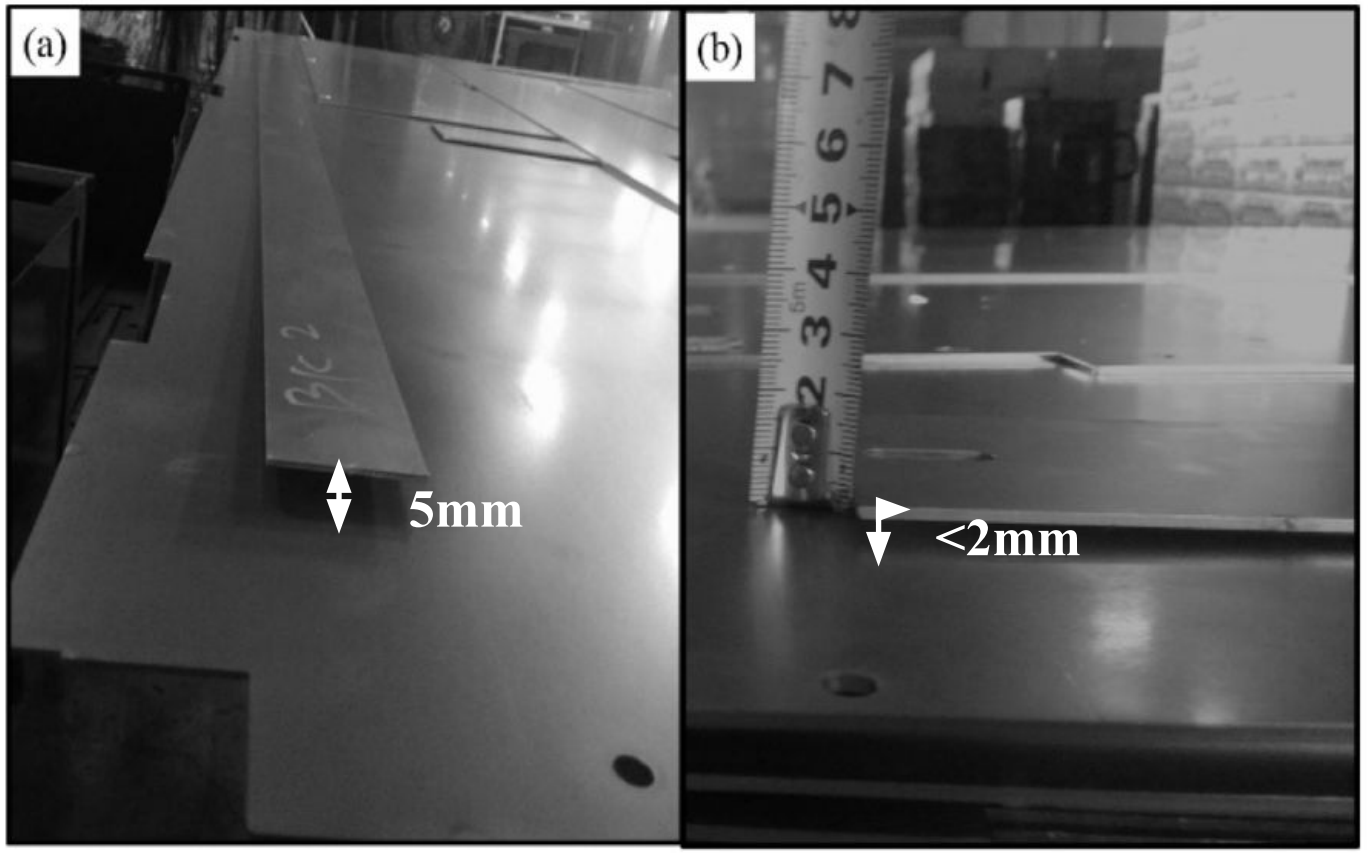
The results by changing CT



1. Changing CT to 580 ℃ **to improve bending**
2. Measure the residual stress again by portable device
3. Acquire the front and back residual stress profile

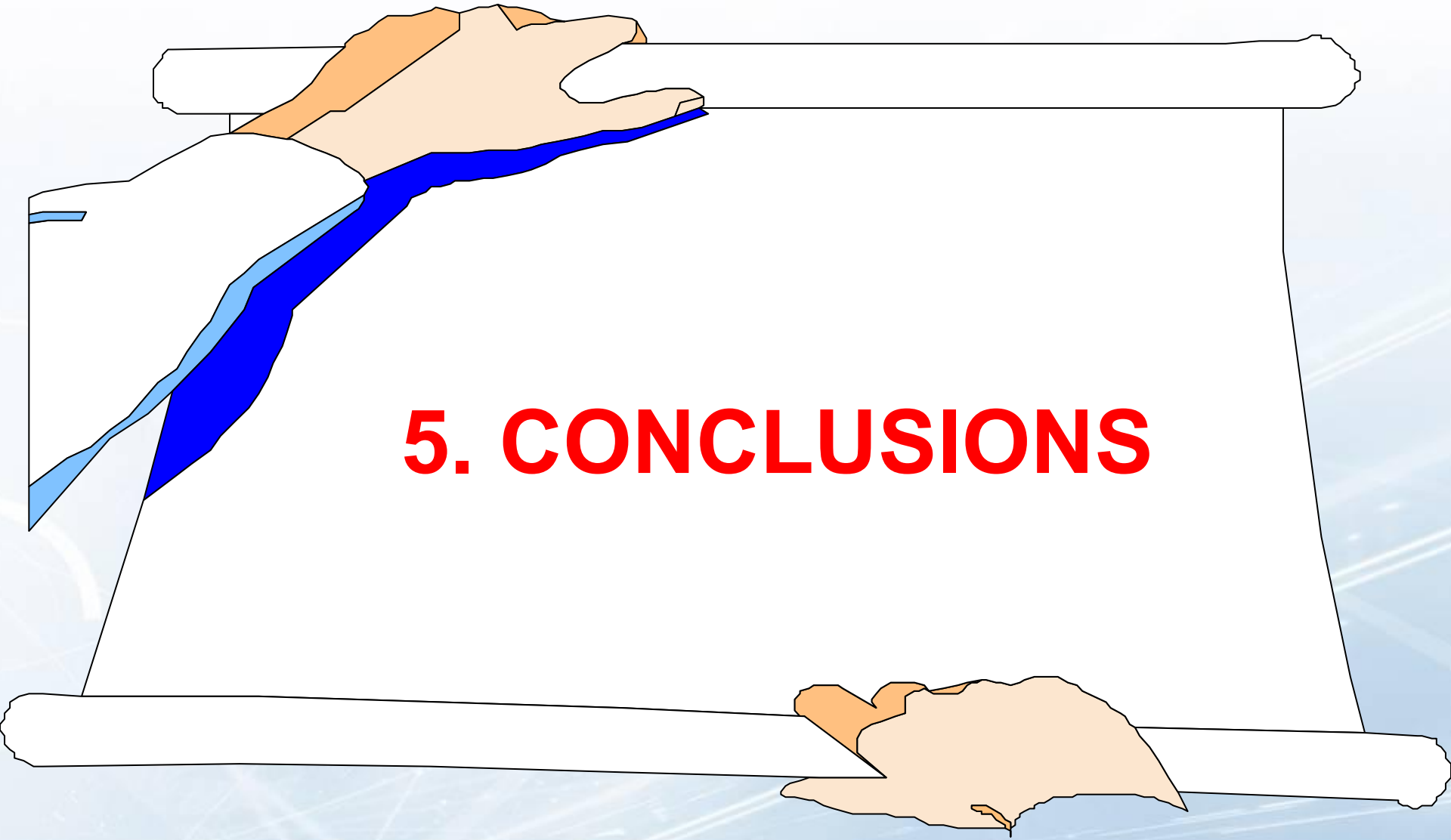
- **On the premise of not significantly affecting the mechanical properties, the CT is regulated at 580℃**
- **The gap becomes smaller after improvement**

The improvement after changing CT



a) Original 5mm deflection

b) Less than 2mm after improvements



5. CONCLUSIONS

Conclusions

- Residual stresses bring harmful effect to steel sheet after cutting.
- In this study, destructive slitting method and non-destructive portable magnetic sensor were used.
- Analyzing the manufacturing process, the key factor to improve residual stress is Coiling Temperature (CT)
- The deflection of the steel sheet is from 5mm to less than 2 mm.
- The quality of the steel sheet had great feedback from customers.

Thank You