Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Investigation of mechanical failure performance of a large-diameter shield tunnel segmental ring

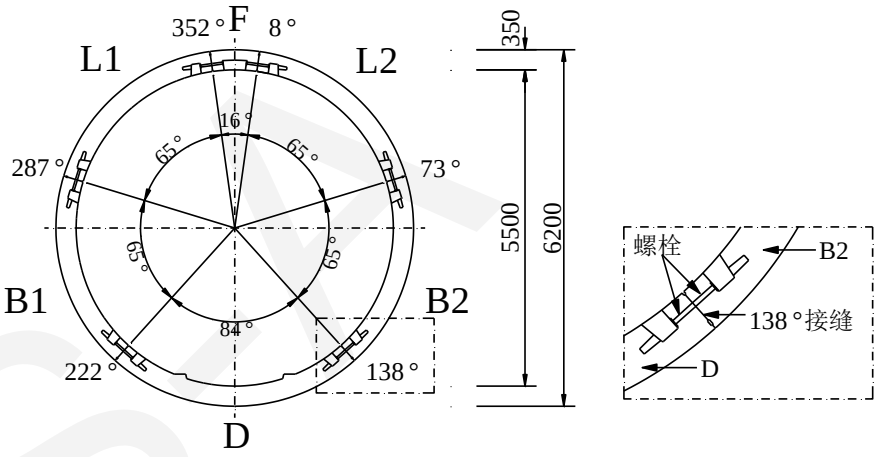
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Research Objective

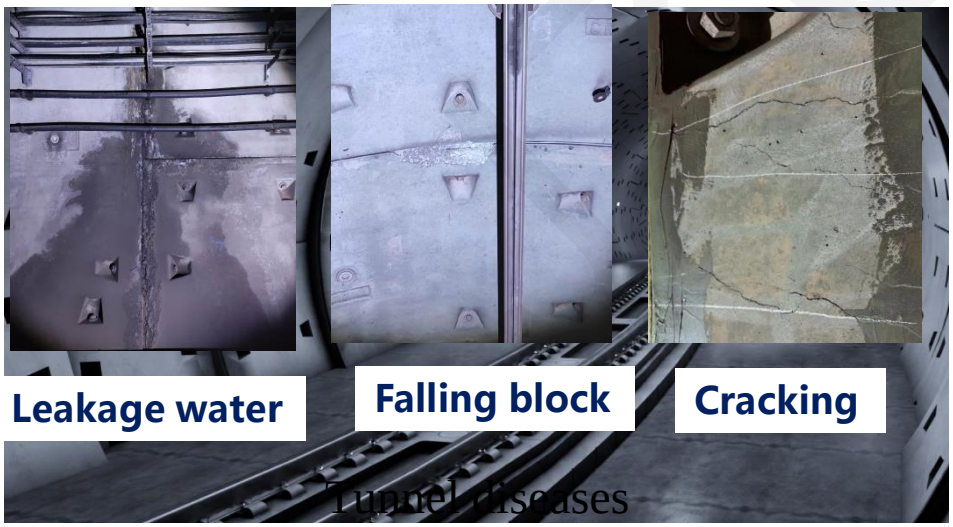


Overloading above the tunnel

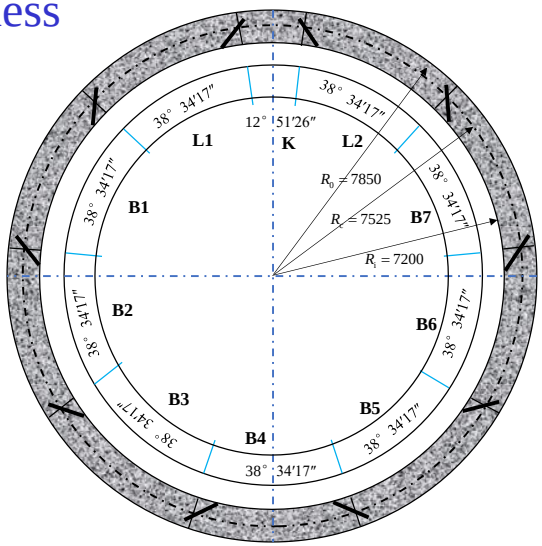


Small-diameter segments

- More blocks
- Larger diameters
- Greater thickness
- More joints

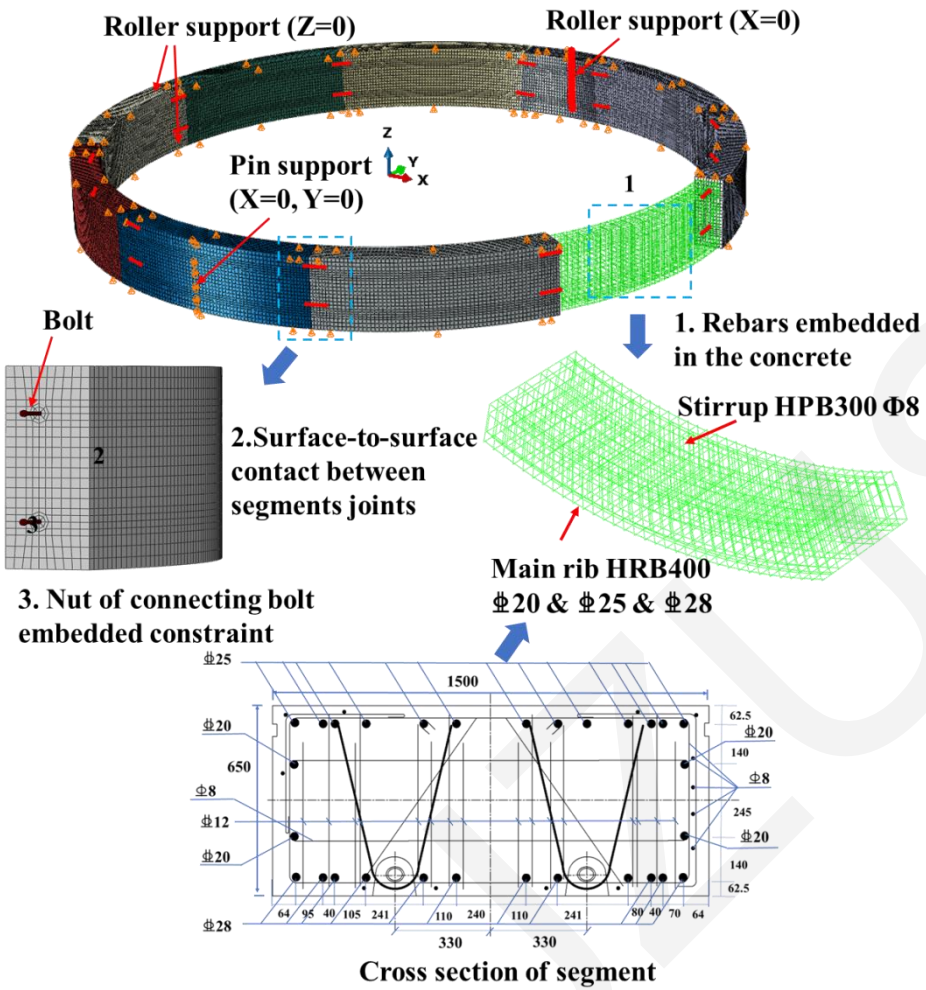


Tunnel diseases

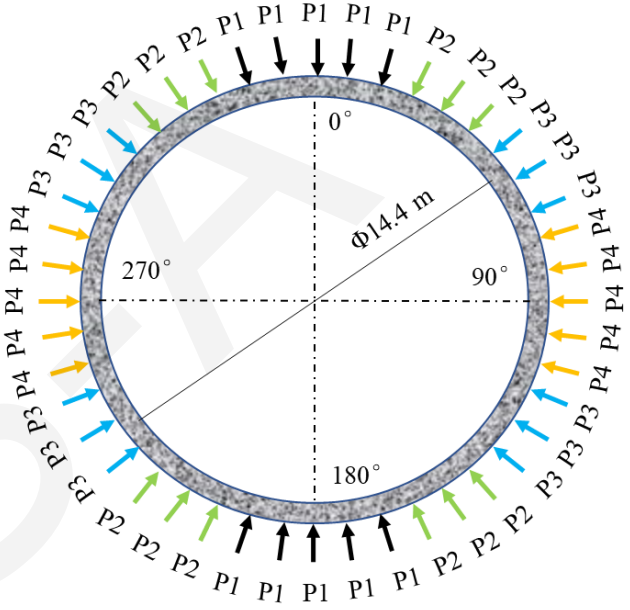


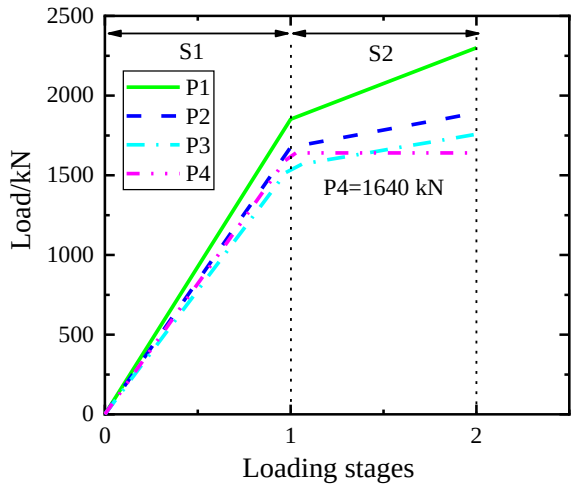
Large-diameter segments

Research Method



Finite element model



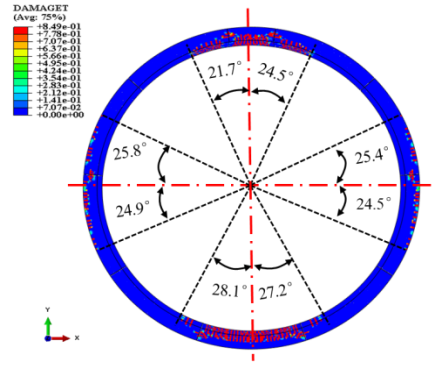


Loading method

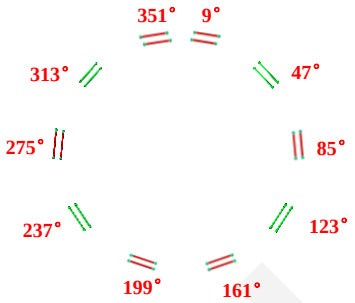
FEM → **Deformation and failure mechanism**

Research Innovation Points

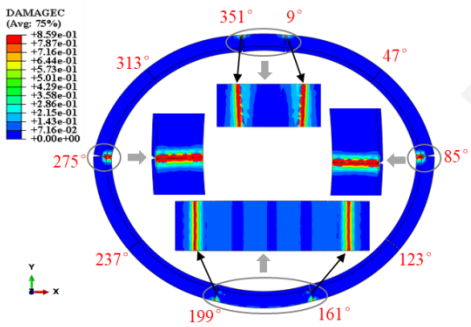
- **By establishing a refined numerical model, the deformation and failure mechanism of the segment ring in large-diameter shield tunnel was analyzed**



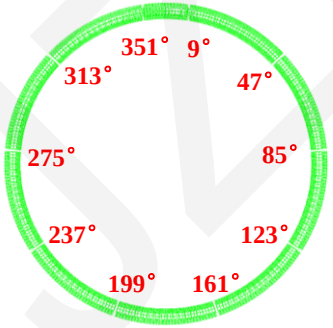
Concrete cracks



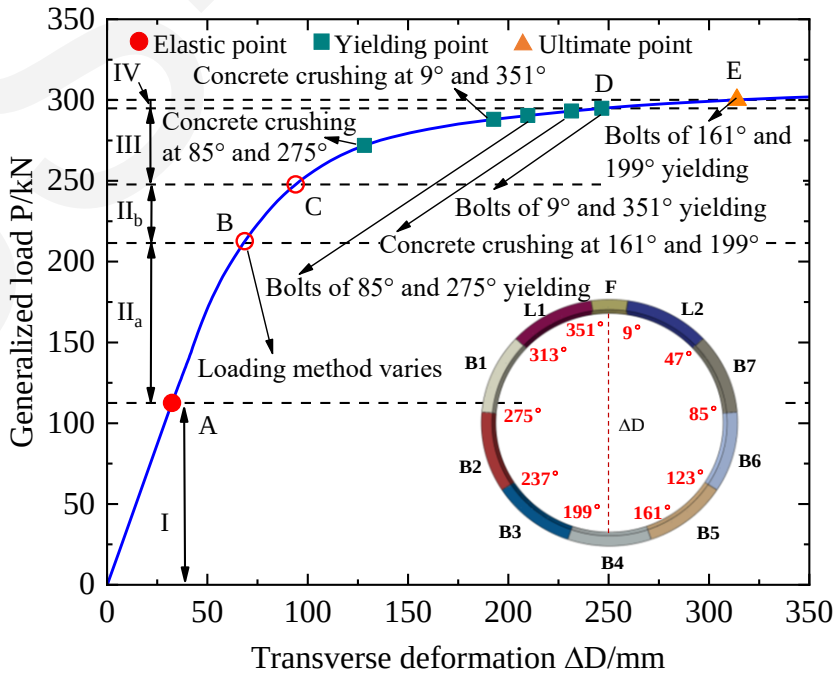
Stress of bolt



Compression distribution



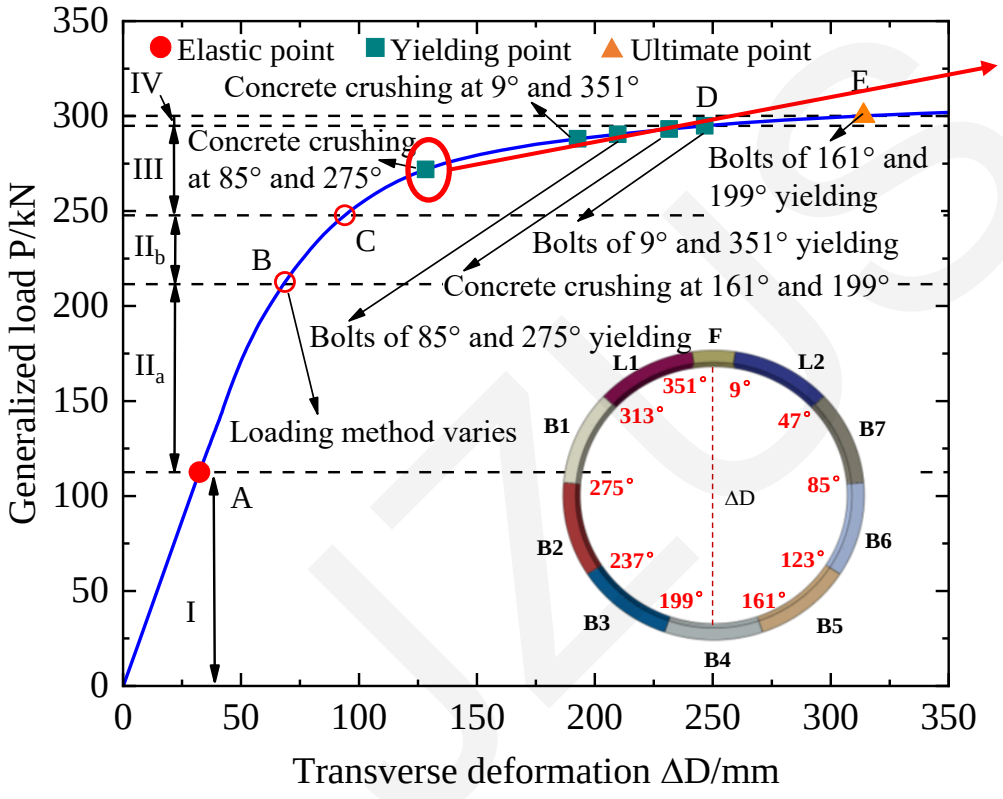
Stress of rebar



Formation process of macro performance points

Research Innovation Points

■ Proposed deformation control standards applicable to large-diameter shield tunnel segments (8‰)



Control point (8 ‰)



Ensure safe operation of tunnels

Formation process of macro performance points.

Conclusions

- The transverse deformation of a large-diameter shield segmental ring can be divided into four stages: i) linear growth stage (Stage I); ii) quasi-linear growth stage (Stage IIa, Stage IIb); iii) nonlinear growth stage (Stage III); iv) failure stage (Stage IV).
- The transverse deformation during the formation of the first semi-plastic hinge (i.e., the first yield point) of the structure is selected as the deformation control value for large-diameter shield tunnel segments and is equal to 8‰ of the segment's outer diameter. This control value can serve as a reinforcement standard for preventing the failure of large diameter shield tunnel segments.