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# Waterproofing performance of longitudinal segmental tunnel joints under external loads: a full-scale experimental investigation

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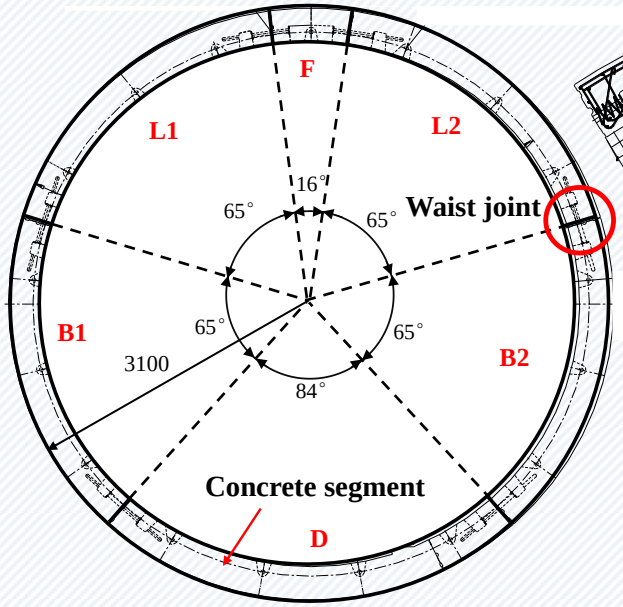
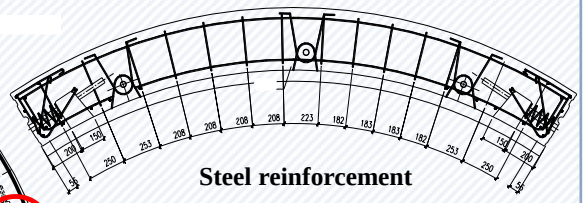
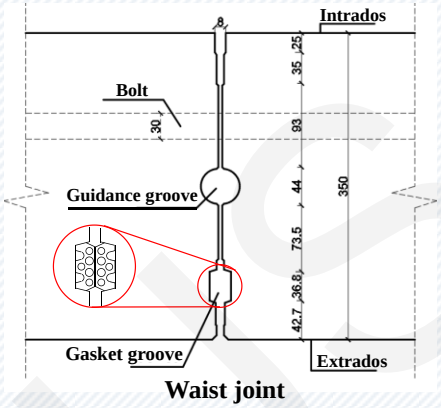
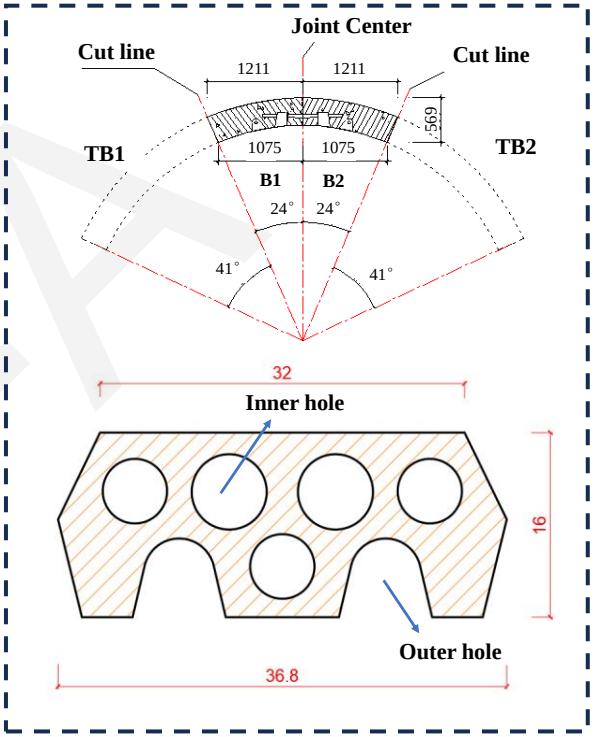
# Testing system design

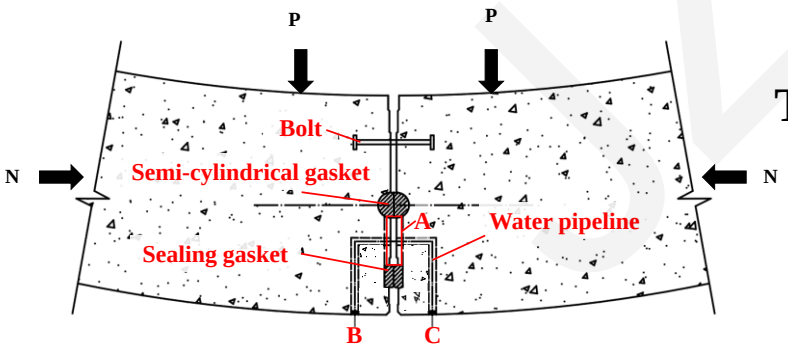


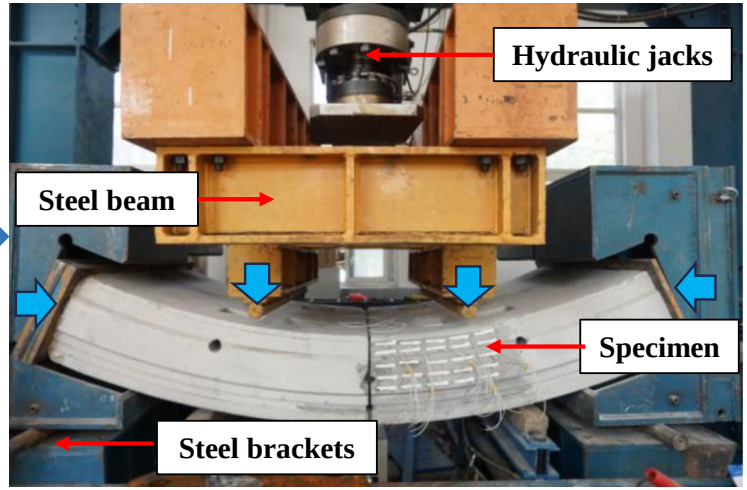




Prototype of the tunnel segmental lining



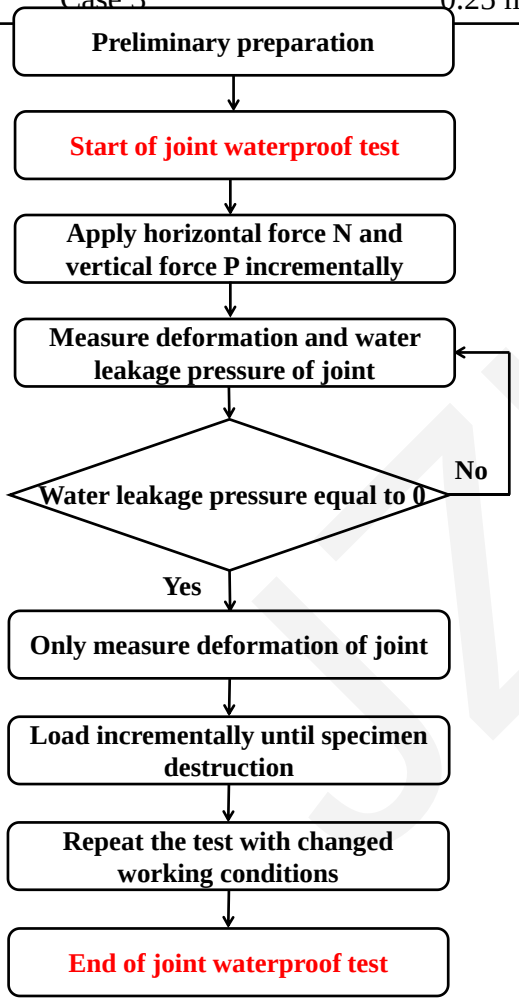

Testing system

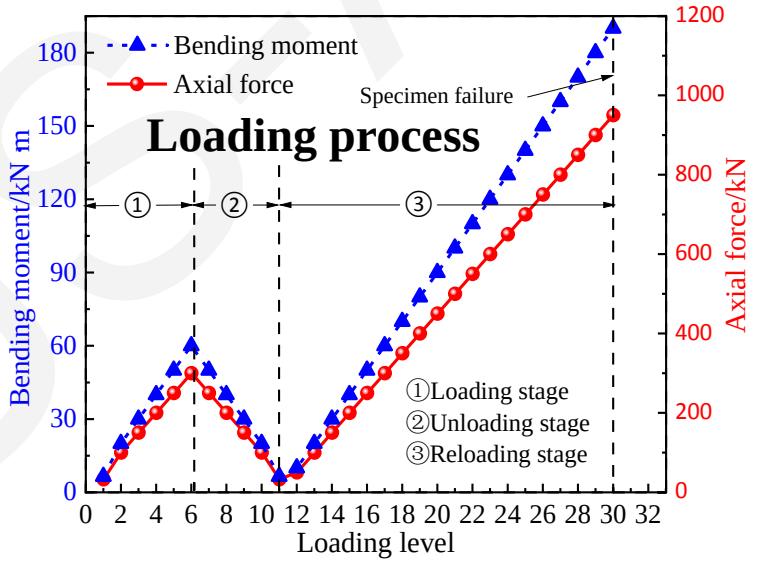


# Test cases and procedure

**Test cases**

| Test case | Eccentricity ($e$) | Loading course |
|---|---|---|
| Case 1 | 0.15 m | Incremental loading |
| Case 2 | 0.2 m | Load-unload-reload cycle |
| Case 3 | 0.25 m | Load-unload-reload cycle |

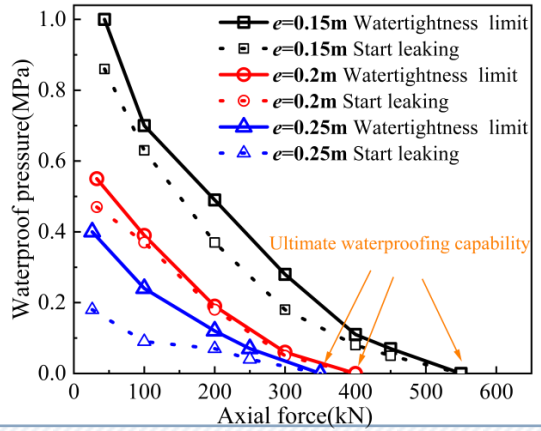


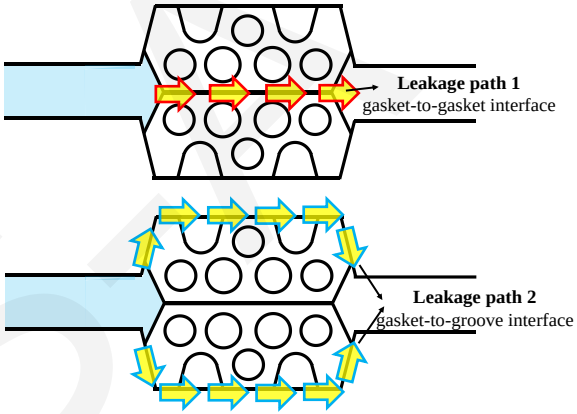




The influence of external loading on the waterproofing performance of longitudinal joints, with regards to **eccentricity**, **magnitude** and **load-unload-reload effects**, are investigated in subsequent tests.

# Experimental results

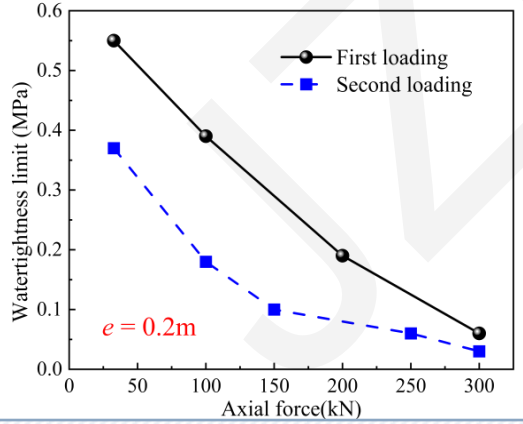
- **Effect of eccentricity and magnitude**

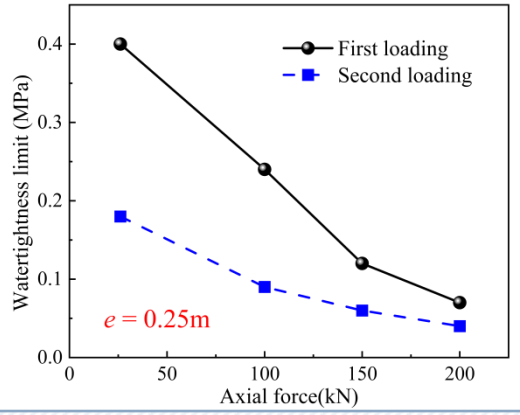



A larger eccentricity in the joint corresponds to a greater bending moment under the same axial force conditions, resulting in more severe joint deformation.

- **Effect of a load-unload-reload cycle**

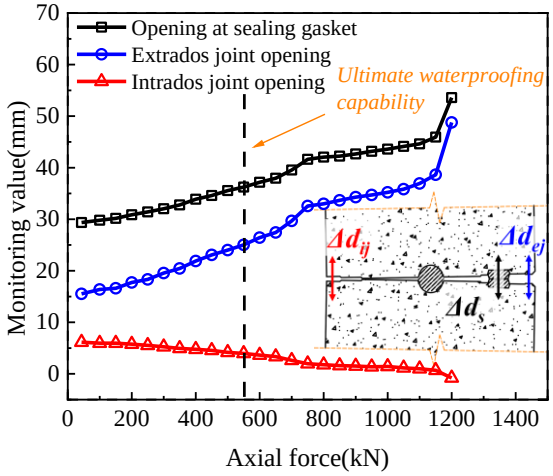


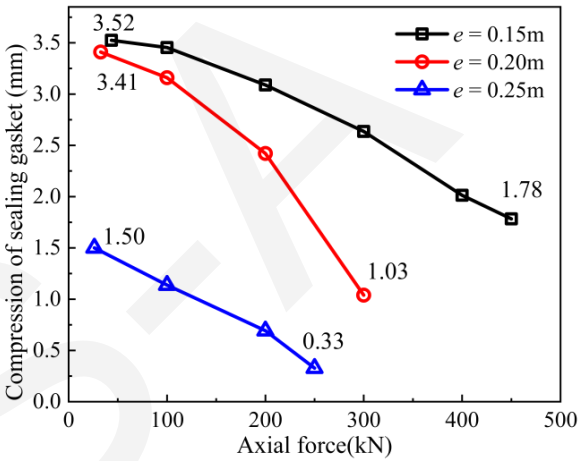




The ultimate watertightness limit of the joint de-creases by approximately 50% during reloading compared to initial loading at the same load level.

# Experimental results

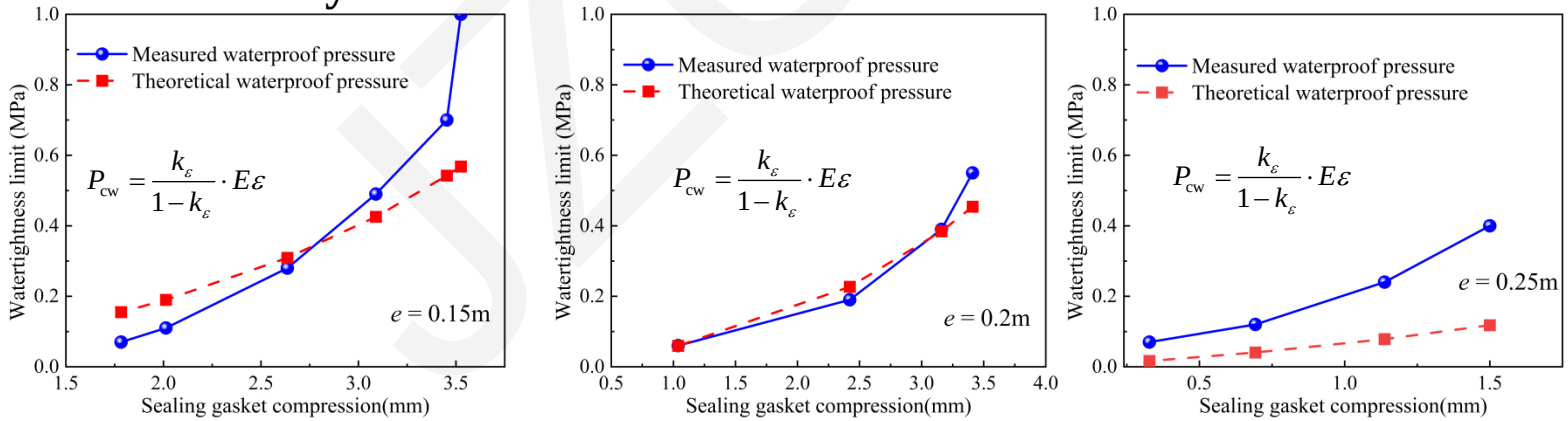
- **Effect of gasket deformation**




Under external loading, the extrados joint gradually opens, while the intrados joint undergoes compression, indicating that the segmental joint rotates.

- **Theoretical analysis**




As the compression of the sealing gasket increases, the watertightness limit increases rapidly.