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Analysis of factors affecting contact stresses in two-bolt connections using finite element analysis

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Introduction

- Multi-bolt connections are widely used in various kind of mechanical structures.

- Their contact stress distribution has an important influence on mechanical properties and reliability of the structures.

- In this work, the influence factors of contact stress in multi-bolt connection are systematically studied using finite element analysis.

Methods

Stresses on the contact surfaces between the two plates are extracted to enable evaluation and analysis of the contact state.

Upper plate hidden
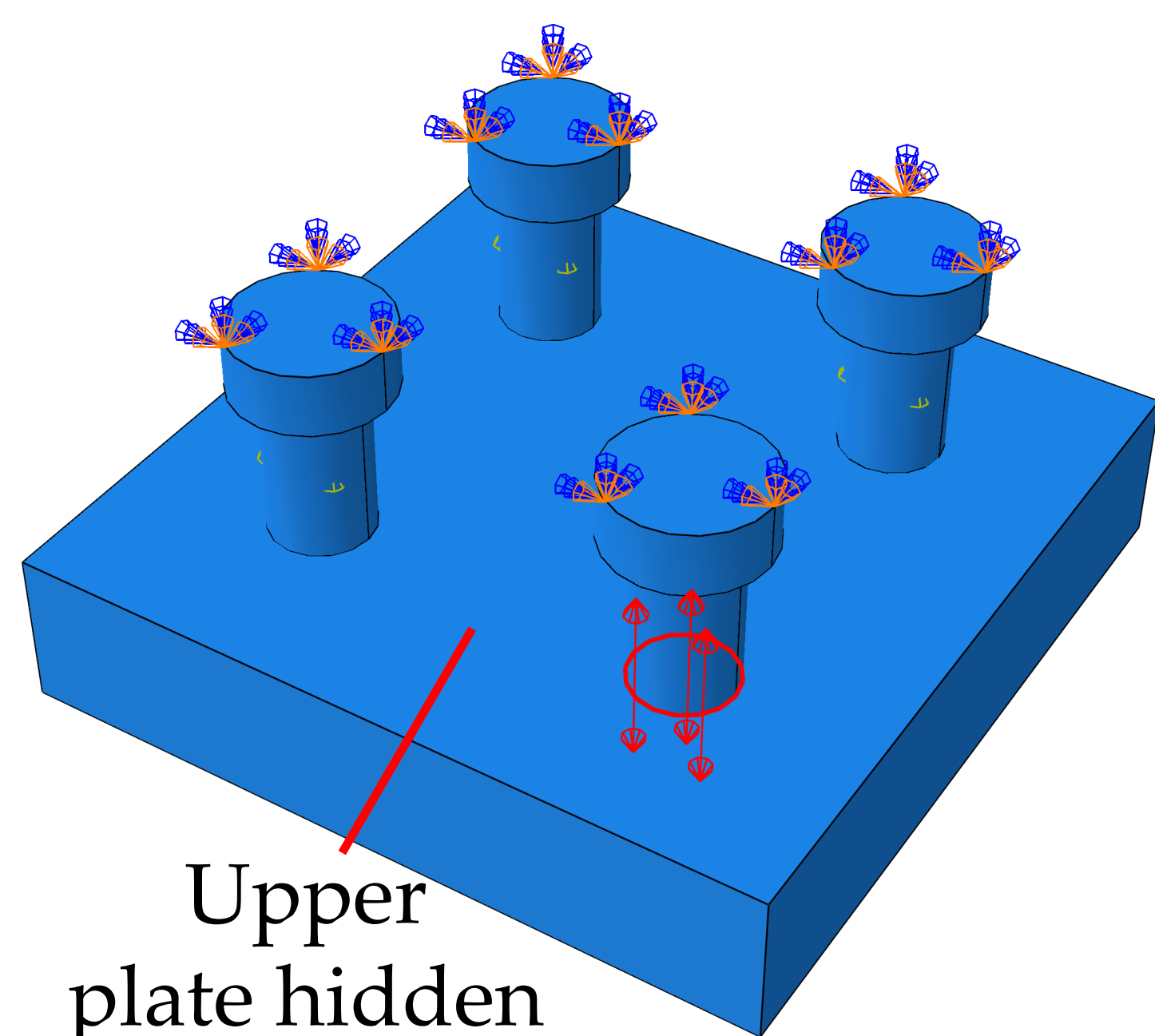
- The bolt heads at top position are completely constrained.

- Four bolt preloads are applied to the middle cross section at the same time.

Fastener: M16, thickness 10 mm, diameter 24.5 mm

Plate: long and width 120 mm, thickness 25 mm with bolt hole 17 mm

Material: Steel, E=213 Gpa, ν=0.287; Aluminum alloy (AL), E=69 GPa, ν=0.33
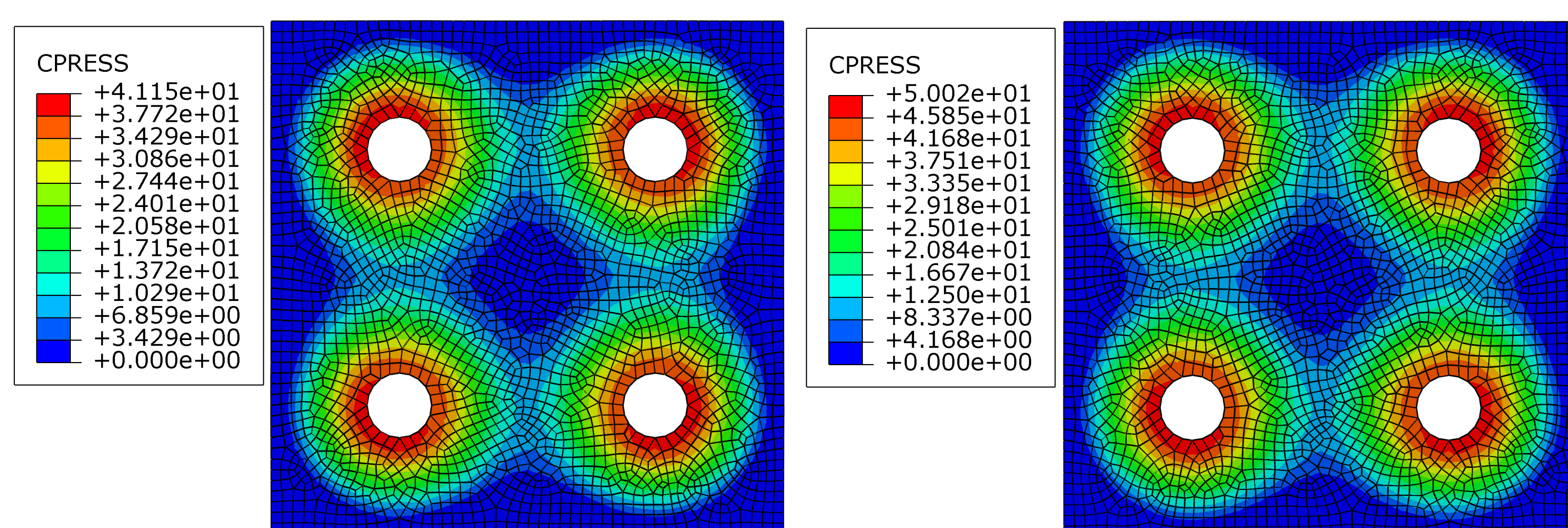
Contact properties: penalty for tangential behavior

Factors involved: 1) bolt preload, 2) material and 3) friction coefficient of the bolted joint.

Results

☐ Influence of Bolt preload

FEA Setup: fasteners and plates are made of steel; friction coefficients are all 0.1.
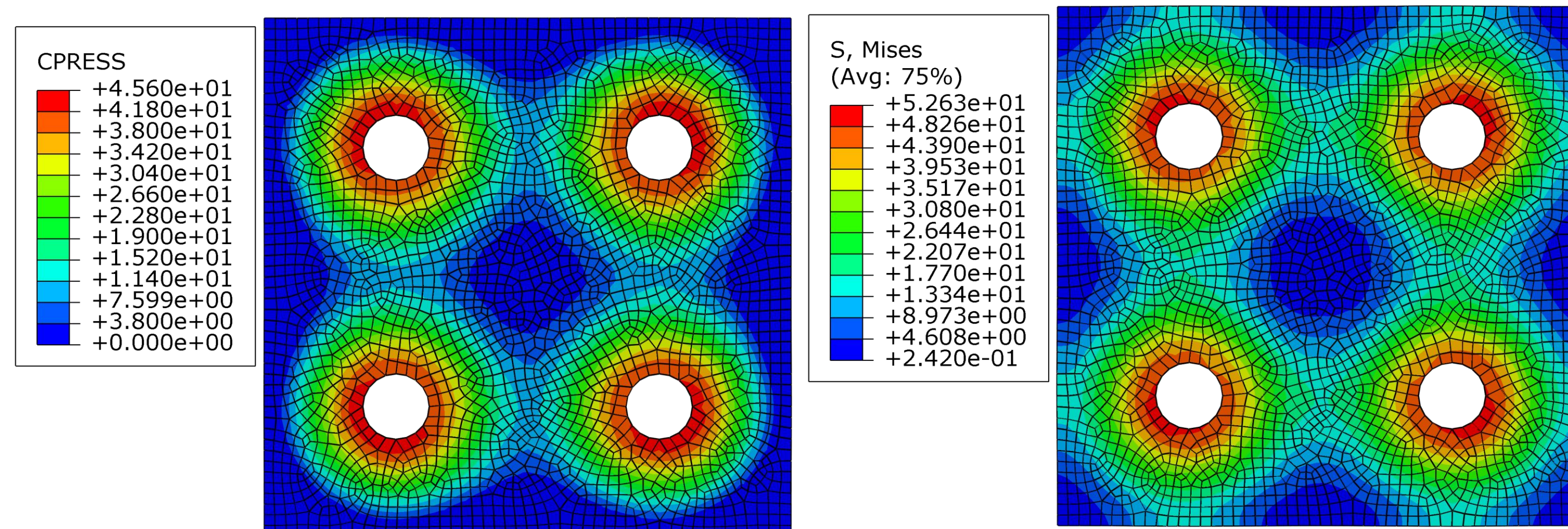

(a) F = 45 kN   (b) F = 55 kN

- Stress distribution pattern on member contact surface is the same for different bolt preloads.

- Contact stress amplitude is positively correlated with the bolt preload.

☐ Influence of plate material

FEA Setup: fasteners are made of steel; plates are made of AL; friction coefficients are all 0.1; bolt preload is 50 kN.
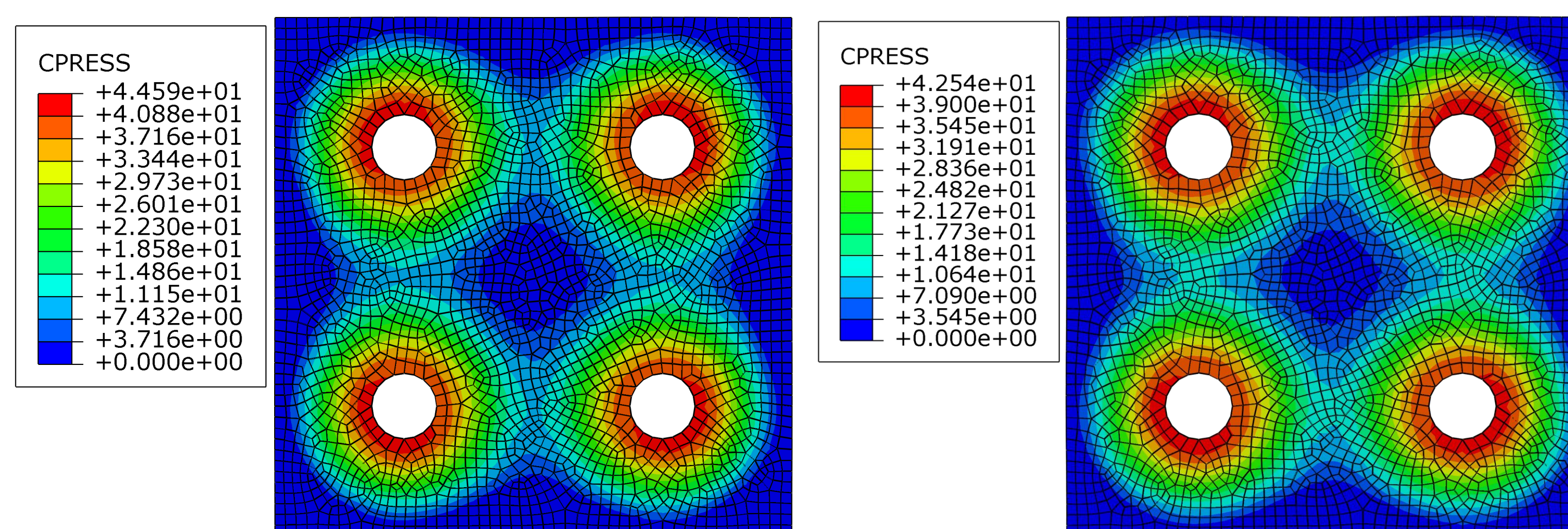

(a) steel   (b) Aluminum alloy

- Connection plates made of aluminum alloy have a larger contact area and contact stress than the steel type.

- Under such conditions, the clamping of the two connection plates is more effective.

☐ Influence of friction coefficient

FEA Setup: fasteners are made of steel; plates are made of AL; friction coefficients are all 0.1; bolt preload is 50 kN.

(a) steel   (b) Aluminum alloy

- For steel plates, the friction coefficient has an almost negligible effect on the contact stress distribution.

- For aluminum alloy plates, the amplitude of contact is larger for small friction coefficient.

Conclusions

1. The influence of three factors on the contact stress distribution is elaborated.

2. It helps to promote the understanding of contact stress distribution via these results.

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