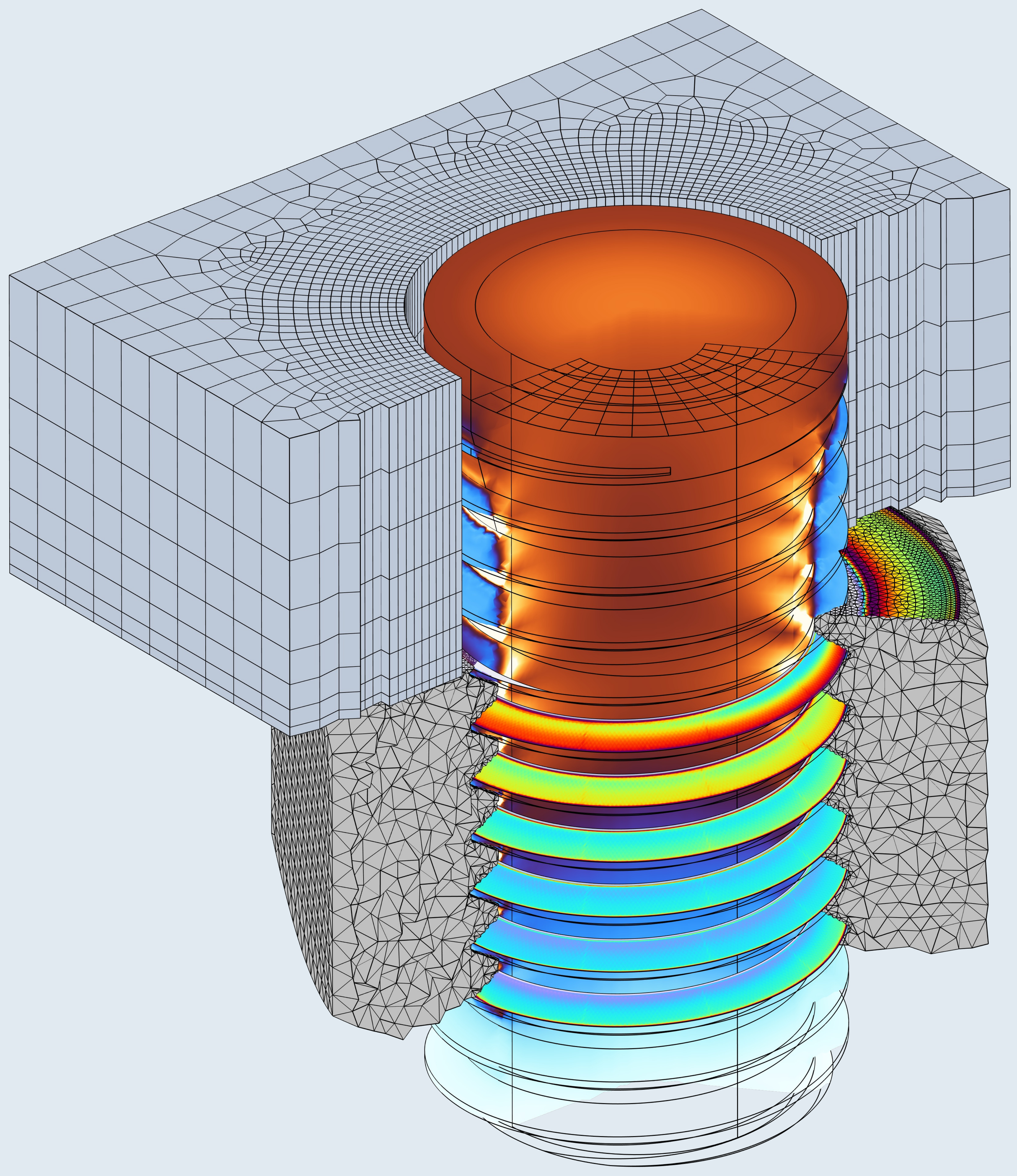

Analysis of the stress and load distribution of a bolt with threaded contact modeled in 3D

Here in this work, the contact pressure and load distribution of a metric thread modeled in 3D are simulated with high accuracy.

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Introduction & Goals

The goal of this work is to determine reliable results of the stress and especially contact pressure distribution of a metric thread accurately modeled in 3D. An assembly consisting of a bolt with metric thread of the type M12, a nut and a support block has been constructed for this purpose with CAD. The assembly partially with breakouts can be seen in an illustration displayed in the header of this poster (see above). Besides the contact pair of the thread, the contact of the nut to the supporting block is also taken into account. This second contact pair is important, because the contact pairs are coupled in some way. Considerations to the concept of force flow resp. stress flow in combination with the simulation results themselves have shown, that the load distribution of the thread is dependent on the through hole diameter of the supporting block, which is in direct contact to the screw nut (see Fig. 2 as vectorial illustration & see Fig. 3 as diagram). Clear and vivid descriptions for this dependency with illustrative simulation results are given in the ‚Scientific Paper' to this topic, too.

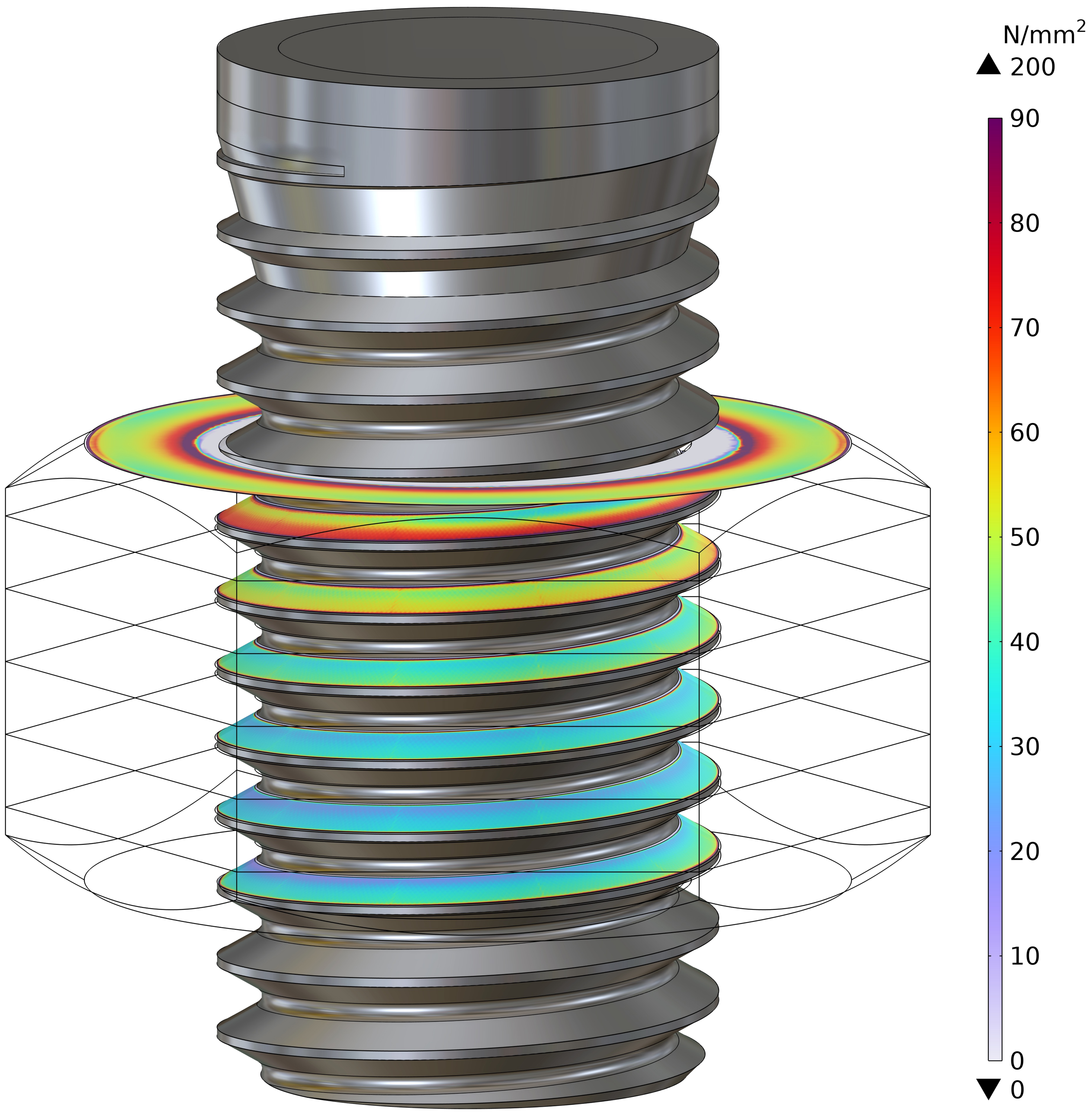

FIGURE 1. Simulation result for an axial force of $F_{preload}$ = 10 kN; display of the contact pressure at the thread and the contact of the nut; additional illustration of the bolt and the edges of the nut

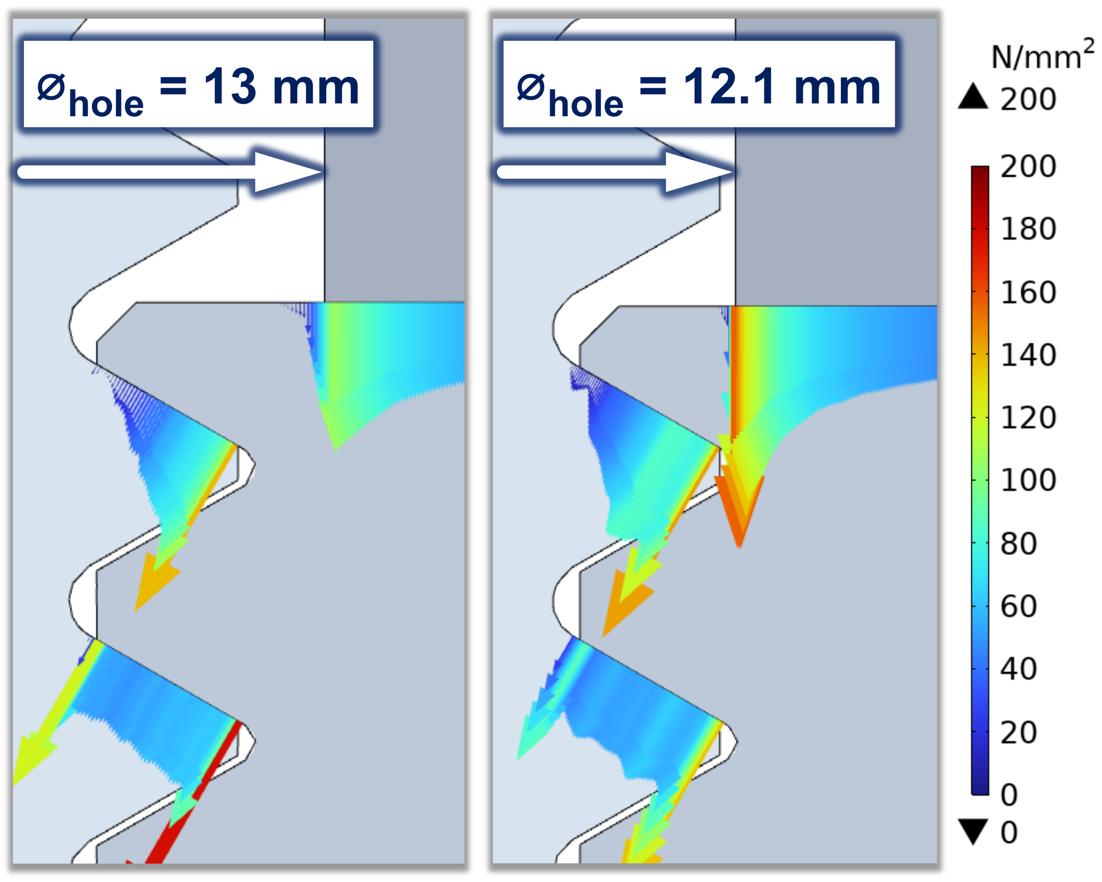

FIGURE 2. Partial view of a vertical, sectional view with illustration of the contact pressure as vectors:
left side: display for $\varnothing_{hole}$ = 13 mm; right side: $\varnothing_{hole}$ = 12.1 mm

Methodology

The simulations are set up linear elastically following the equation $\sigma = \varepsilon \cdot E$ for a constant Young's modulus E. The simulations are geometrically nonlinear due to the contact modeling. Both contact pairs are defined with the contact method "Augmented Lagrangian" in contrast to the less accurate "Penalty" method. For stabilization issues, a spring foundation has been used.

The discretization 'Quadratic Lagrange' has been applied for an appropriate accuracy. A very fine mesh at the surface of the thread contact with a side length of Δs = 30 µm of the triangles has been created.

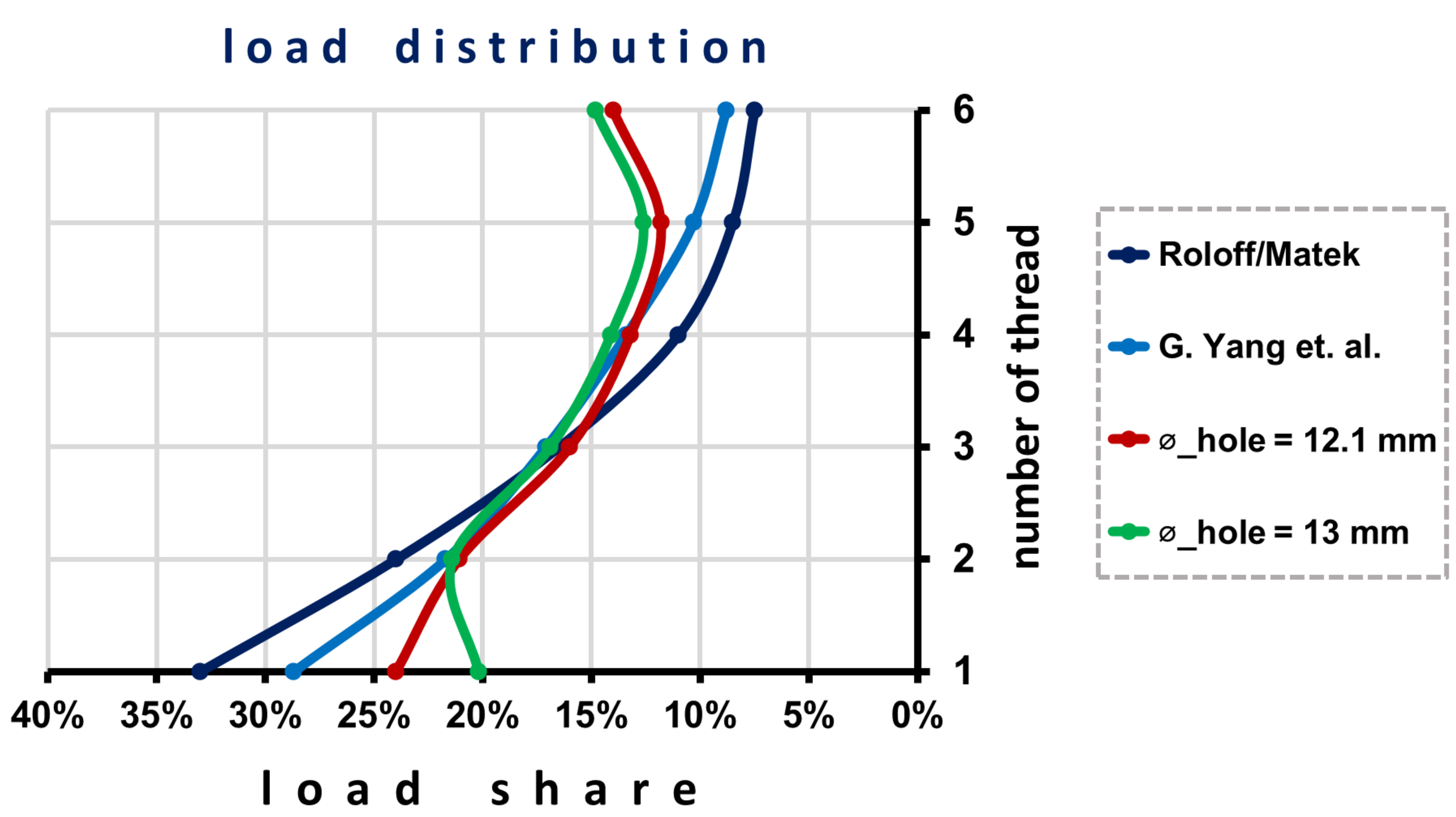

FIGURE 3. Diagram with different load distributions in direct comparison; through hole diameters simulated here in this work with ⌀ = 13 mm & ⌀ = 12.1 mm; other load distributions (see Ref. 1 & Ref. 2)

Results

A pressure distribution with a very high resolution at the thread contact could be determined due to the use of a very fine finite element mesh (see Fig.1). The evaluation of the load distribution shows that there are large deviations compared to other sources (see Fig. 3). The differences are plausibly described and explained in the accompanying ‚Scientific Paper'.

REFERENCES

1. G. YANG et. al., "Three-dimensional Finite Element Analysis of the Mechanical Properties of Helical Thread Connection", CHINESE JOURNAL OF MECHANICAL ENGINEERING, Vol. 26, No. 3, pp. 564 to 572, 2013.
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