A novel fully-prefabricated steel-UHPC composite deck is proposed for completely eliminating the on-site wet construction, as shown in Fig. 1. The composite bolting-welding joint is the key structure of the prefabricated deck system. Two sets of specimens are designed for the deep investigation on the mechanical performance of this composite deck. The strain distributions, crack development and load-deflection curves are obtained. On the basis of physical test, a sophisticated numerical model is built in ABAQUS, which presents satisfactory accuracy. The influences of some important design parameters are discussed through supplementary parametric analyses. Finally, the design suggestions are provided according the test and analysis results.

Fig. 1 Structure of the fully-prefabricated steel-UHPC composite deck system
with the diameter of 18 mm were used to enhance crack resistance of the steel-UHPC interface. One end of the PT-rebar was tapped and the screw nut was placed in the thick plate for anchorage. The other end is embedded in the UHPC layer.

Classic four-point bending test was conducted to obtain the crack development, strain distribution and load-deflection curves of the specimens. According to the test, Set A presented evident advantages on the crack resistance performance, which had a quite large initial cracking stress and nominal tensile stress in post-cracking stage.

![Specimen and loading setup](image)

**Fig. 2 Specimen and loading setup**

The crack development is shown in Fig. 3. Set A presented more satisfactory crack resistance. With PT-rebar, the initial cracking stress was evidently enhanced. But the pretension rebar could not significantly enhance the post-cracking

![Crack development at the steel-UHPC interface](image)

**Fig. 3 Crack development at the steel-UHPC interface**

### 3. Finite element analysis

To supply the physical test, finite element analysis was built in ABAQUS, which could well reproduce the load-deflection curves and crack development of the bolting-welding joint.

![Numerical model in ABAQUS](image)

**Fig. 4 Numerical model in ABAQUS**

With the numerical model, the effect of pretension force and height of the stiffener were investigated. According to the results of parametric analysis, the regression formula of estimating the initial cracking stress was derived.

\[
\sigma_{\text{initial}} = 8.4 \left( p \frac{F_p}{65} + b \frac{h_s}{109} + c \right)
\]

where \( F_p \) was the pretension force in one rebar, \( h_s \) is the height of stiffener; \( a = 0.4466 \), \( b = 0.06361 \) and \( c = 0.5616 \) were the coefficients for regression.

### 4. Conclusion

Employing PT-rebar could evidently improve the initial cracking stress, but hardly improve the nominal stress in seriously cracking stage.

Based on parametric study, the initial cracking stress is more sensitive with the pretension force, while increasing the stiffener height could evidently improve the nominal tensile stress in seriously cracking stage.

### 5. Reference

Culmo M P. Prefabricated composite bridges in the United States including total bridge prefabrication [C]//Workshop on Composite Bridges with Prefabricated Deck Elements. 2009.