The immersed (tube) tunnel has 33 tunnel elements; each element was submerged on the sea bottom and then covered. The typical tunnel element is 180 m long, 38 m wide, and 11.4 m high, and has a mass of 76 000 t. The foundation work was difficult because the work had to be performed continuously in a sedimentation environment. All tunnel elements were placed on slopes with varied longitudinal gradients of 0%–3%. The water depth of the foundation work was up to 50 m at the deepest point, and the typical tunnel element’s bottom area was 8000 m²; regarding the bottom area, the contact surface of the placed gravel bed had a leveling requirement of not greater than 4 cm. To achieve these criteria, the project invested nearly 3 billion CNY to develop specialized facilities, a deep-water survey technique, a high-accuracy dredging technique, a sedimentation removal and control technique, and a deep-water foundation layer construction technique. For the prefabrication of the tunnel elements, 1 billion CNY was invested to build an immersed tunnel element prefabrication factory on a massive scale. This is only the second time that an immersed tunnel factory has been built; the first case was for the Oresund Tunnel [1]. It is the first time that curved tunnel elements have been prefabricated by a factory method; furthermore, crack control involving the casting of self-waterproofing concrete with a volume of nearly 1 × 10⁶ m³ was realized. The project continuously and safely installed 33 immersed tunnel elements; in addition, developments were made during the process to the following techniques: (1) the large-volume element-towing technique, used for offshore and confined navigational channels; (2) the deep-water and deep-trench tunnel element-installation technique; (3) the deep-water fully automatic immersion system; and (4) the adjustment-free immersed tunnel element underwater-installation technique. Moreover, the new structural concept of a semi-rigid element in an immersed tunnel was studied in order to increase the longitudinal robustness of the structure and solve the problem of high overload due to the deeply buried tunnel position. The novel concept of a composite foundation layer for an immersed tunnel was innovated in order to control the settlement and differential settlement at a relatively low magnitude. (Some data regarding past immersed tunnel projects have been published in Ref. [2].) An active water-stop integrated closure joint technique was innovated in a breakthrough to ease the difficulties of the final underwater connection. Based on trial-and-error experimentation, “memory bearing” was invented in order to mitigate the risk of...
structural damage or cracking as a result of differential settlement at the tunnel immersion joint.

In 2013, after the invasion of the super-severe Typhoon Haiyan, the project engineers evaluated the project’s hazard standards in terms of the local development tendencies for hazardous weather, and optimized the project’s design for hazard prevention and control, thereby comprehensively increasing the construction site’s hazard-prevention capability. During construction, the project successfully withstood a frontal attack by Typhoon Hato. At present, the project has reached the last stage of finishing touches; by the end of 2017, the fundamental conditions are planned to be in place, and the tunnel will be opened to traffic.

References