※Josei Measurement Technology;②-5

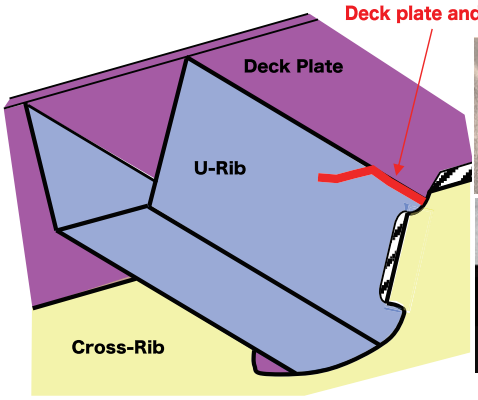
Repair Measures for Existing Bridges

Overseas Project / Cambodia in JICA Chroy Changwar Bridge Steel Deck Fatigue Crack Countermeasures

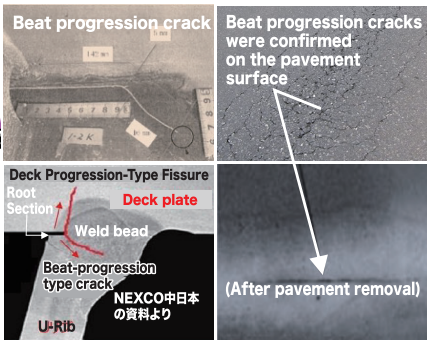
The Chroy Changwar Bridge is a bridge spanning the Tonle Sap River in Phnom Penh, Cambodia, constructed in 1963 with technical assistance from Japan. In 1972, it was blown up and collapsed due to the Cambodian Civil War. It was rebuilt in 1994 as the Japan-Cambodia Friendship Bridge, funded by Japan's grant aid. Currently, in rapidly developing Phnom Penh, increased distribution from rural areas has inevitably led to traffic and logistics volumes significantly exceeding the bridge's original capacity. Fatigue cracks were discovered in the steel deck section, necessitating comprehensive renovation. Kamiharu was involved in evaluating the load-bearing capacity and verifying the feasibility and effectiveness of countermeasures

Study on Countermeasures for Fatigue Cracks in Steel Deck Plates

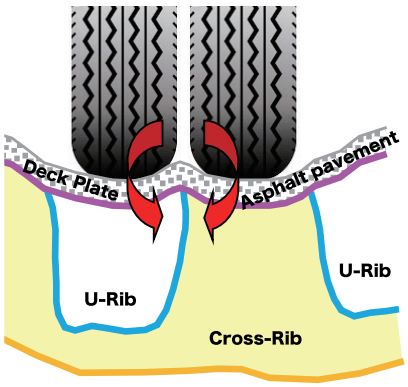
The results of the on-site magnetic particle inspection (lower center photo) clearly revealed cracks in the deck plate and U-rib welds. These are known as root-penetrating cracks, which fully propagate from the root through the weld bead and appear on the surface. Cracks penetrating the deck plate also exist, propagating from the root through the deck plate. Cracks aligned with the U-rib lines were visible on the asphalt pavement surface of the bridge. Upon removing the pavement, cracks penetrating the deck plate were confirmed. These cracks are highly likely to have been caused by insufficient stiffness of the U-ribs and deck plate, leading to deformation and rotational movement, as shown in the lower right diagram.



【Fatigue Crack Occurrence Overview】

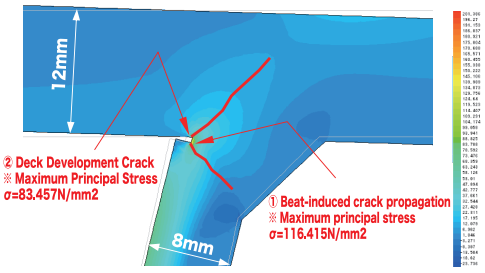


【Cracks detected by magnetic particle inspection】

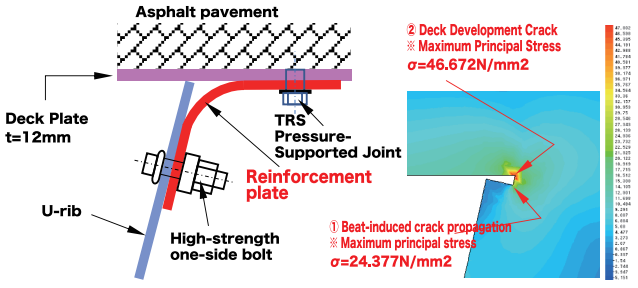


【Fatigue Crack Initiation Mechanism Due to Radial Load Application】

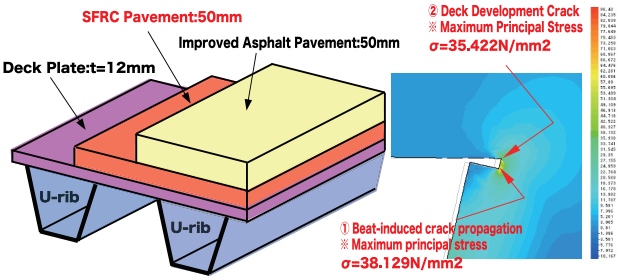
As countermeasures, we evaluated ① deformation control using backing plate reinforcement and ② stiffness enhancement using SFRC pavement through FE analysis.
The current maximum principal stress levels are σ=116.415 N/mm² at the beat crack progression section and σ=83.457 N/mm² at the deck crack progression section, confirming extremely high local stress levels.
Both countermeasures ① and ② showed significant local stress reduction effects. However, for countermeasure ① (reinforcement with backing plates), it was confirmed that local stresses in the deck crack progression area tended to be higher than those in the beat crack progression area. This led to the determination that its effectiveness in extending the service life against fatigue cracks was low. Consequently, it was ultimately decided to implement countermeasure ②: increasing stiffness through SFRC paving.



【Current FEM Analysis Results】



【Countermeasure ① Brace Plate Reinforcement FEM Analysis Results】

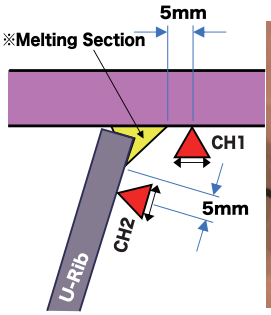


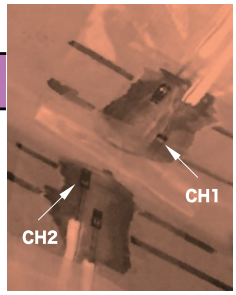
【Countermeasure ②: FEM Analysis Results for SFRC Pavement】

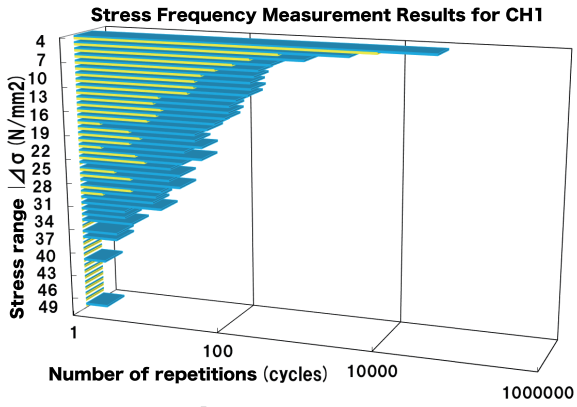
Verification of Reinforcement Measures Effectiveness

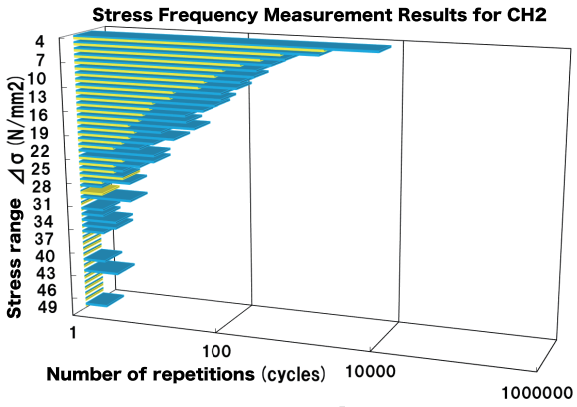
As shown in the photo below, construction began in January 2017 and was completed in June 2019. At Josei, stress frequency measurements were conducted before and after the countermeasures to verify the effectiveness of the reinforcement measures.

The photo on the right shows the installation overview and condition of strain gauges on the sound section where no beat progression cracks have occurred. The strain gauges are bonded to the deck plate and U-ribs at a position 5mm from the weld. Traffic volume on the Chroy Changwar Bridge currently exceeds 45,000 vehicles per day. Stress frequency measurements were conducted for the 12-hour traffic period from 7:00 to 19:00 on weekdays.
The ■ in the lower graph represents the stress frequency results before countermeasures, while ■ represents the results after countermeasures. A significant reduction in count numbers can be confirmed for both CH1 and CH2. Furthermore, stress levels above 30 N/mm² have been reduced to zero, indicating that the countermeasures have sufficiently extended the fatigue life.









【Verification of Reinforcement Effectiveness Using Stress Frequency Rules; CH1 and CH2】

The Chroy Changwar Bridge was renovated and reopened to traffic in 1992 through Japan's grant aid. It was named the " Japan-Cambodia Friendship Bridge" by King Sihanouk at the time. The banknote shown here is Cambodia's 500 riel note, featuring the flags of both Japan and Cambodia printed on it, a visible symbol of trust in Japan.
I am pleased to have been involved in the renovation plan for the Chroy Changwar Bridge, which had suffered significant damage. This project has enabled stable land transportation and contributed to strengthening Cambodia's economic foundation.

Visiting the site now, you'll find a monument expressing gratitude to Japan at the bridge entrance (Phnom Penh side) (see photo below). Seeing this makes you truly feel, 'I'm involved in work that helps people!!' It was a project that brought me back to my original purpose: to continue working diligently and humbly, sparing no effort, so that Josei can contribute to people's happiness!!

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