

**“Technical Research and Development for Road Policy Quality Improvement”
Study Summary**

No.	Title	Principal Researcher
No.29 - 6	Development of lightweight concrete slab with expansive admixture which contributes to improvement of productivity and reduction of life cycle cost	Prof. Toshiharu Kishi, The University of Tokyo

In order to put lightweight concrete slab with expansive admixture into practice use from the viewpoint of productivity improvement and life cycle cost reduction, pumpability test both in summer and winter and mock-up fatigue test by the wheel moving load were conducted.

1. Backgrounds and Objects

In order to study on lightweight concrete slab with expansive admixture for productivity improvement and life cycle cost reduction, 1) fatigue resistance by the wheel moving load test, 2) constructability by pumping test and 3) freeze-thaw test were examined to clarify the technical specifications of lightweight concrete with the expansive admixture for the best performance and the structural details (i.e. slab thickness, vertical reinforcement, etc.) for lightweight concrete slab. The lightweight concrete slab could reduce the dead load of the bridge superstructure, and it would contribute extremely to seismic load reduction in the substructure which can save the bridge entire construction cost significantly.

2. Activities in Research Period

The slab “Matsu-B” with chemical pre-stress due to the moderate amount of expansive admixture was developed in fiscal 2017, focused on on-site versatility with fatigue resistance equivalent to ordinary RC slab. Based on the above results, the slab “Matsu-A” with proactively induced chemical prestress due to the excessive amount of expansive admixture was developed in fiscal 2018, whose low water-cement ratio concrete with self-healing performance achieved the lighter weight and further durability.

The pumpability test equivalent to horizontal distance of 150 m, the mock-up fatigue resistance test by the wheel moving load, and the freeze-thaw test specified in Japan Industrial Standards (JIS) were carried out.

3. Study Results

Pertaining to the slab “Matsu-B”;

(1) The technologies for lightweight concrete with low water amount for civil structures have been confirmed to construct reliably by pumping.

(2) The best amount of expansive admixture for proper chemical prestress is confirmed.

(3) It is confirmed by the wheel moving load test that it is equivalent in fatigue resistance to the ordinary RC slab which the Public Works Research Institute carried out in the past. (Refer to Figure-1)

(4) It is confirmed with 2 types of ordinary lightweight concrete that the freeze-thaw resistance is not improved by an increase of air content, but improved by previously lowering water saturation in the lightweight coarse and fine aggregates. (Refer to Figure-2)

The slab “Matsu-B” is for cast-in-place use and equivalent in fatigue resistance to the ordinary RC slab. It costs less in construction than after-mentioned slab “Matsu-A”. The versatile use of lightweight concrete can save the manufacturing and construction costs of the superstructures and substructures.

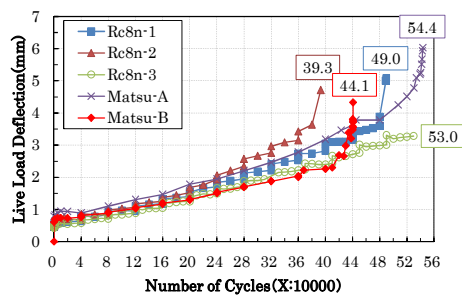


Figure-1 Results of Wheel Moving Load Tests Pertaining to the slab “Matsu-A”;

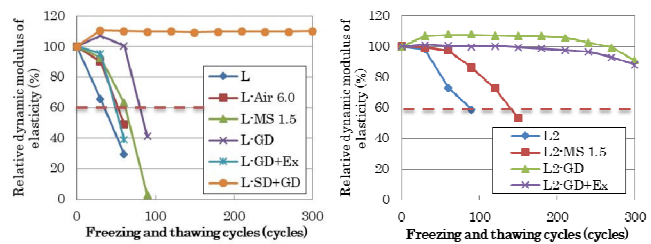


Figure-2 Results of Freeze-Thaw Tests

(1) It is confirmed by the wheel moving load test that it has excellent fatigue resistance in comparison with the past results of the ordinary RC slab conducted by the Public Works Research Institute. (Refer to Figure-1)

(2) It is clarified with 2 types of lightweight concrete from the results of the freeze-thaw test that the freeze-thaw resistance is not improved by an increase of air content, but improved if the lightweight coarse aggregate contains less water because water contained in lightweight fine aggregate moves out to the paste portion in low water cement ratio. (Refer to Figure-2)

The slab “Matsu-A” is superior in fatigue resistance to the ordinary RC slab even 3 cm less in slab thickness due to the 3D chemical prestress effect brought by matching the expansive admixture overdosed than shrinkage compensation and the vertical confinement steel bars.

4. Papers for Presentation

(1) Study on pumpability: “Study on the 2 types of lightweight concrete mix that can be pumped year-round”, Utsumi Kazuhito, Masahiko Kishida, Nobuyuki Tanaka, Tatsuya Muramatsu, Toshiharu Kishi, and Tomohisa Kamata, JSCE Annual Meeting 2019.

(2) Study on fatigue resistance: “Study on the fatigue resistance of lightweight RC slab with expansive admixture”, Masahiko Kishida, Hitoshi Tajima, Kouichi Kitamura, and Toshiharu Kishi, Vol.41, No.2, pp 715-720, JCI, Annual Convention 2019

5. Study Development and Future Issues

Having planned the pilot projects in the Metropolitan Expressway, available construction data will be collected. This innovative and cost-effective technology will be registered in NETIS (New Technology Information System) and disseminated nationwide for bridge design engineers. As chemical prestress can be introduced to the slab just by adding the expansive admixture, the durable slab can be easily manufactured overseas if “lightweight aggregate” and “expansive admixture” can be arranged.

6. Contribution to Road Policy Quality Improvement

Not only cost-saving by downsizing of the steel girders and substructures, this technology can contribute to the existing structures such as insufficient load capacity substructures, existing lightweight concrete slab and the thinner slab designed before 1971. In addition, the lightweight slab (“Matsu-B” by 20%, “Matsu-A” 30% reduced respectively) can improve the earthquake resistance of the structures and meet with the “National Resilience” policy. Furthermore, the chemical prestressed slab “Matsu-A” can be manufactured in a pre-cast factory without any special technique nor additional facilities. As “Matsu-A” is expected to save 7% of construction costs comparing to the conventional slab, the utilization of this new technology will contribute significantly to the quality improvement of road administration.

7. References, Websites, etc.

The research results are continuously disseminated through publication in the peer-reviewed articles and active presentation at domestic and international technical meetings.