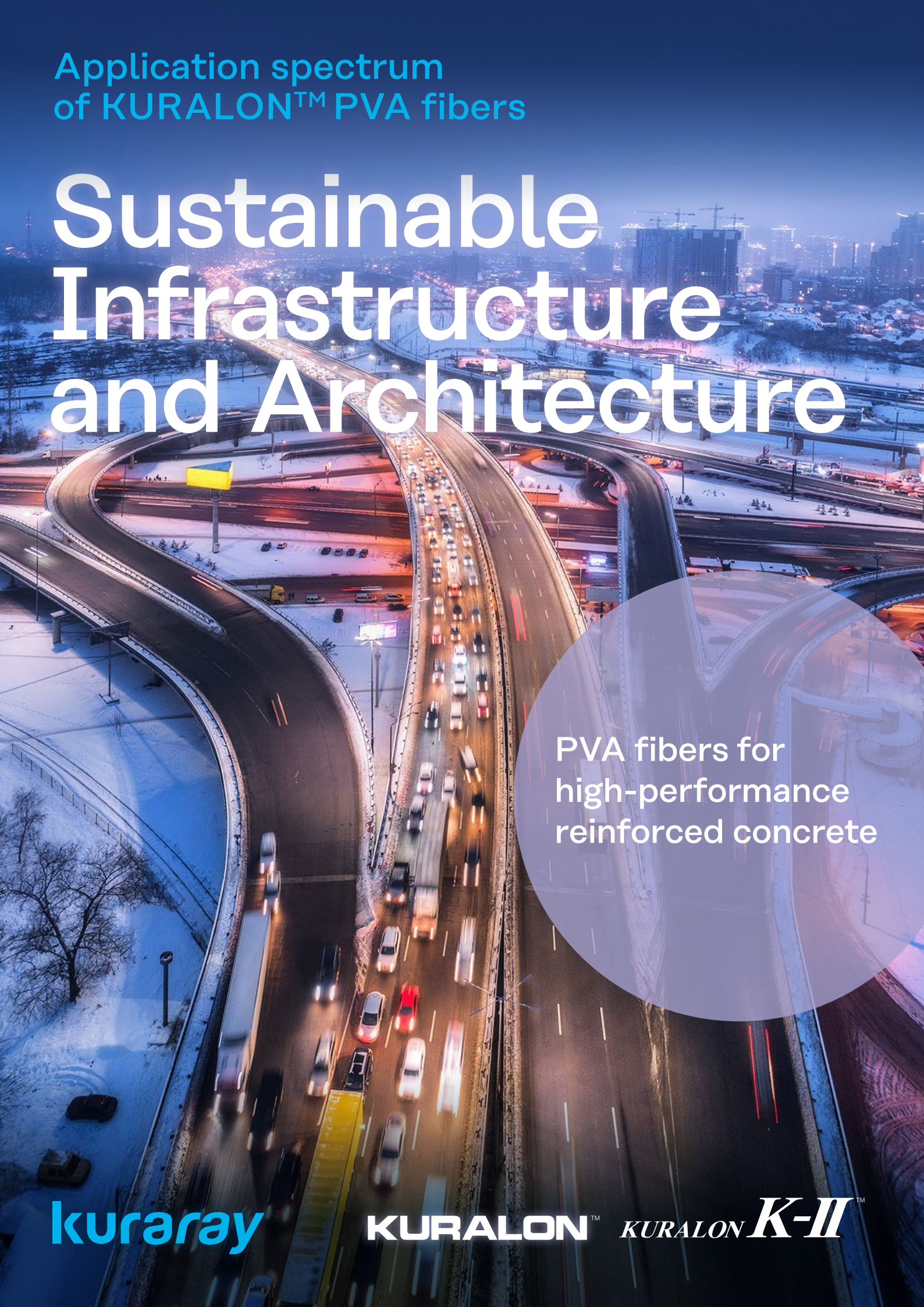
Application spectrum
of KURALON™ PVA fibers

# Sustainable Infrastructure and Architecture



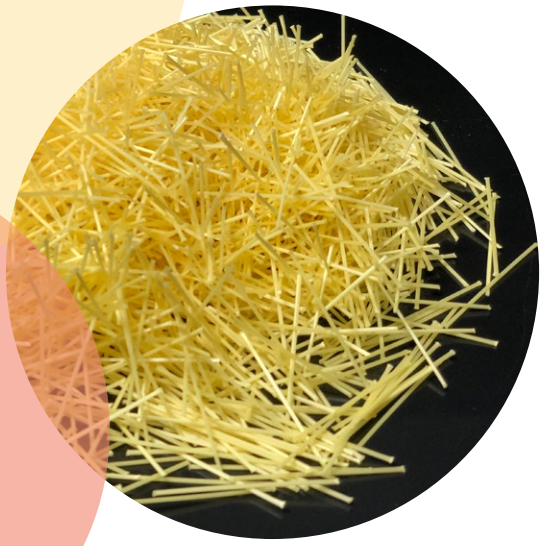
PVA fibers for
high-performance
reinforced concrete

kuraray

KURALON™ KURALON K-II™

# KURALON™ and KURALON K-II™ – PVA fibers with outstanding properties to meet demanding requirements.

KURALON™ is a synthetic fiber made from PVA (polyvinyl alcohol) resin. Kuraray started commercial production of this fiber in 1950 and it now has a long history of use in cement composites as a substitute of asbestos. By applying our expertise in cement reinforcement, we have now built up a strong track record in concrete reinforcement applications as a contribution to sustainable infrastructure.



**Special features**

- High strength
- High modulus
- Low elongation
- Good adhesion to cement matrix
- Alkali resistant
- UV resistant
- Lightweight
- No corrosion

**KURALON™ and KURALON K-II™ have unique properties compared with other fiber materials such as steel, AR glass and polypropylene.**

| | | KURALON™ KURALON K-II™ | Steel fiber | AR glass fiber | Polypropylene fiber |
|---|---|---|---|---|---|
| **Tensile strength** | **MPa** | 850-1790 | 800-1200 | 2400 | 300-760 |
| **Young's modulus** | **GPa** | 23-45 | 200 | 70-80 | 23-25 |
| **Density** | **g/cm³** | 1.3 | 7.85 | 2.78 | 0.91 |

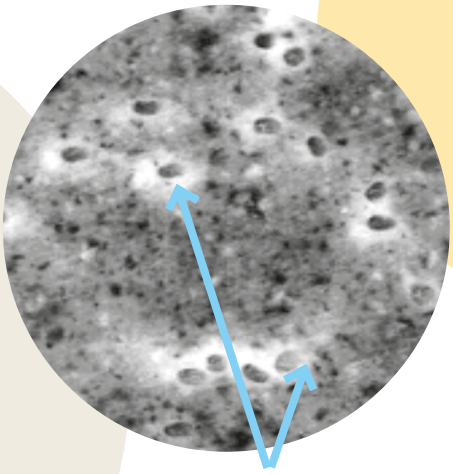
Not guaranteed values.

KURALON™ and KURALON K-II™

# Special industrial fibers with good adhesion to the cement matrix.

PVA fibers that form a chemical bond with the cement matrix.

Ca+ in cement slurry is attracted by PVA and forms calcium deposits. The assumption is that the calcium compounds are important for adhesion.



White areas: calcium compounds

KURALON™ and KURALON K-II™

# For concrete infrastructure

## The ideal fiber for the repair and reinforcement of roads and bridges.

KURALON™

# Overview for concrete infrastructures

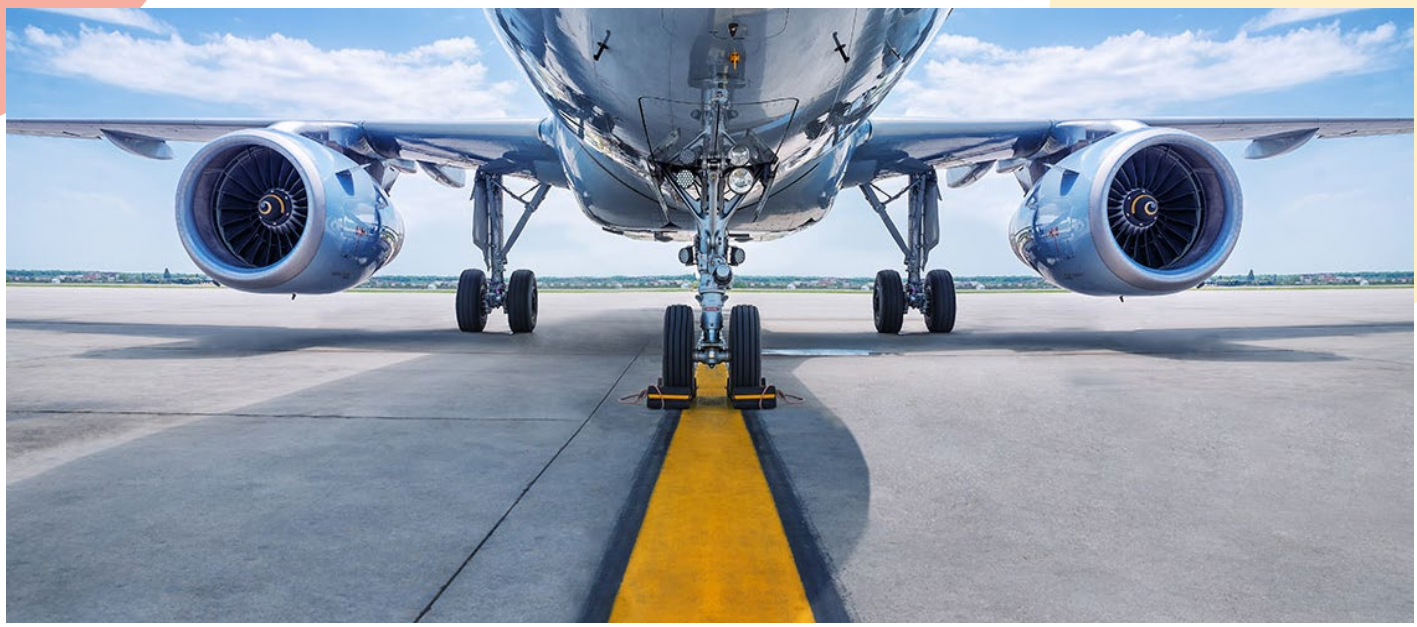
KURALON™ is a synthetic fiber made from PVA, which is suitable for durable, low-maintenance concrete infrastructure. This can reduce the carbon footprint and increase cost efficiency over the life cycle of the infrastructure. Moreover, its good affinity to cement leads to better crack control in severe conditions, such as cold weather and heavy loading traffic.

**Applications**

- PVA fiber-reinforced concrete slab deck of bridges
- Concrete pavement for heavy traffic loads (scrap yards/airports)
- Permanent concrete formwork which reduces rehabilitation

**Benefits**

- No/fewer metal elements (No/less corrosion) → Less maintenance
- Less cement required → Lower $CO_2$ emissions



| Fiber | Diameter [µm] | Length [mm] | Density [kg/m³] | Dosage | |
|---|---|---|---|---|---|
| | | | | Vol % | (kg/m³) |
| **KURALON™ RF 4000** | 660 | 30 | 1.3 | 0.46-0.75 | 6.0-10 |

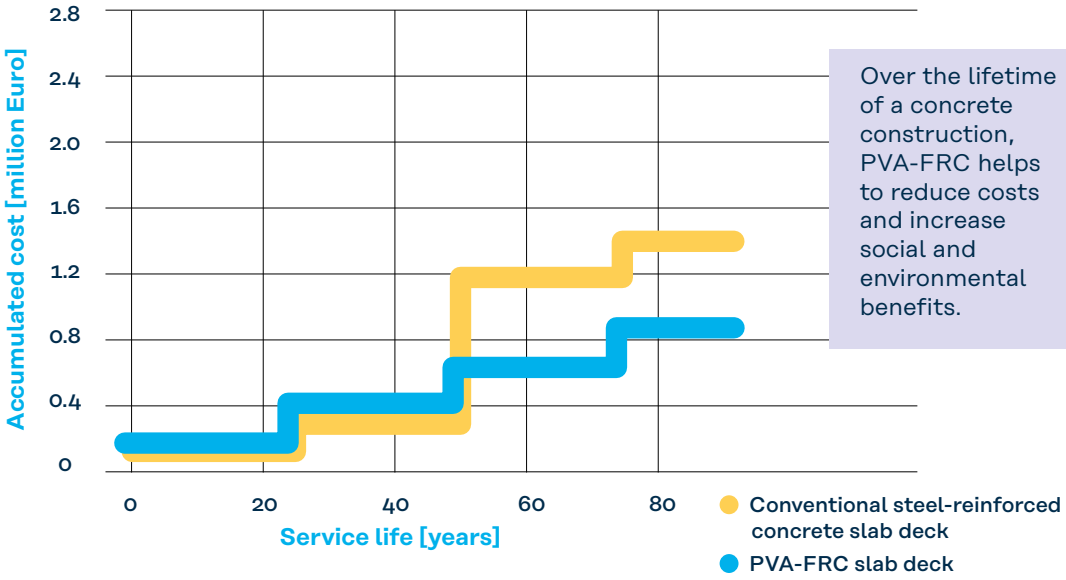
* Diameter: value derived from the cross-section of the fiber and converted as if it were a circle.
* This item has CE certification and complies with EN 14889-2 for synthetic fiber for the reinforcement of concrete.

Case study

KURALON™

# 1. Focus on the lifetime benefits

Life cycle cost analysis based on a PVA-FRC slab deck for a bridge




Over the lifetime of a concrete construction, PVA-FRC helps to reduce costs and increase social and environmental benefits.

**Basis of calculation**

This study is based on the guideline for LCC of constructions published in 2004 by Japanese Civil Engineering Consultants Association.

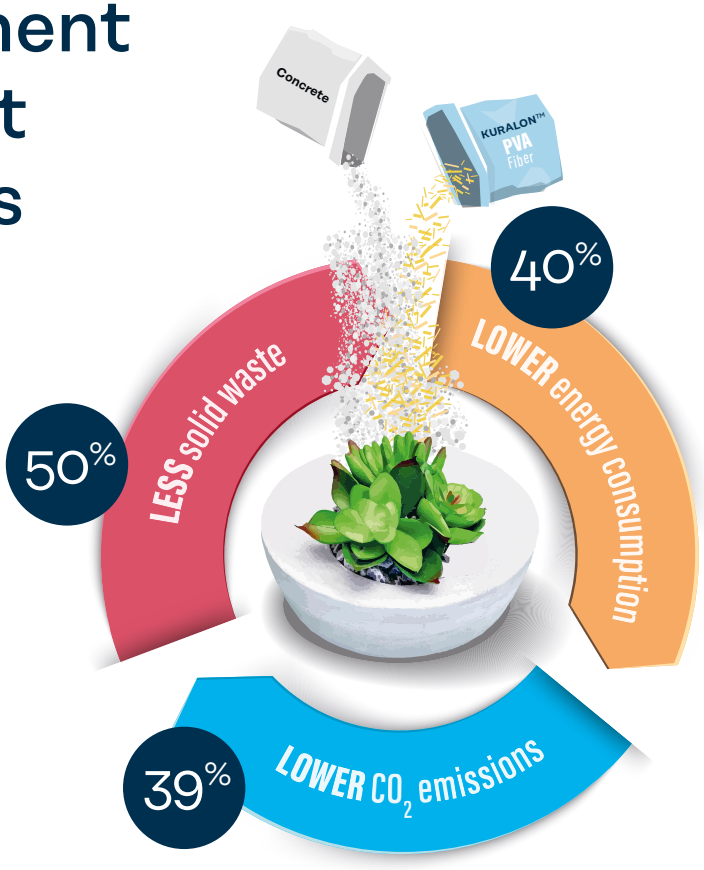
In this study, we assumed partial repair every 25 years without any renewal construction for 100 years, assuming a PVC-FRC slab deck.

**Result of study**

The initial cost of the PVA-FRC slab deck is a little higher than the commodity RC deck slab, but the total cost over 50 years is lower than using the commodity method.

# 2. Life cycle assessment of the PVA-FRC joint slab deck for bridges

Advantages of PVA-FRC over conventional systems*



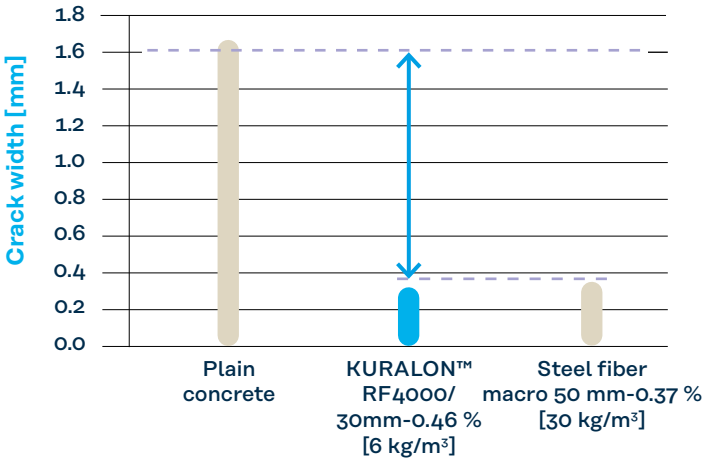

*Keoleian et al. estimated that the ECC link slab system consumes 40% less total primary energy and produces 39% less carbon dioxide in comparison with the traditional steel joint system.[1)]
Keoleian et al. estimated that the ECC bridge deck system has significant advantages in environmental performance: 40% less life cycle energy consumption, 50% less solid waste generation, in comparison with the traditional steel joint system.[2)]

1) Keoleian , G.A., et al., (2005), "Life Cycle Cost Model for Evaluating the Sustainability of Bridge Decks"
2) Keoleian , G.A., et al., (2005), "Life Cycle Modeling of Concrete Bridge Design: Comparison of Engineered Cementitious Composite Link Slabs and Conventional Steel Expansion Joints"

KURALON™ and KURALON K-II™

# Durability of slab decks on highway bridges with KURALON™

## Comparison of dry shrinkage suspension

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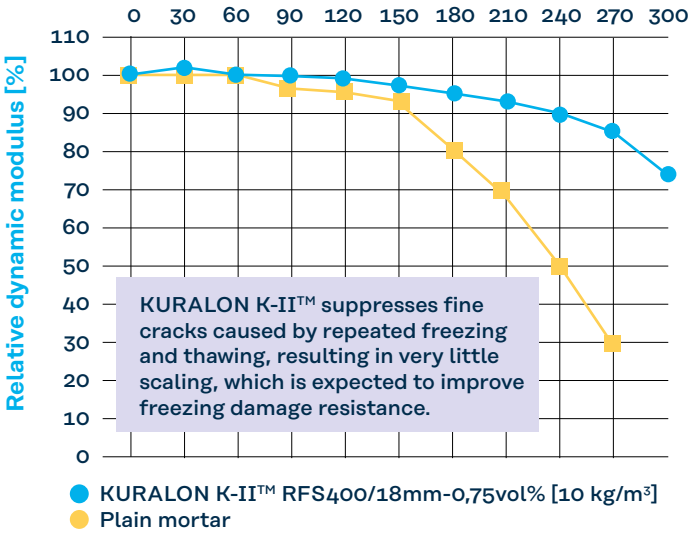
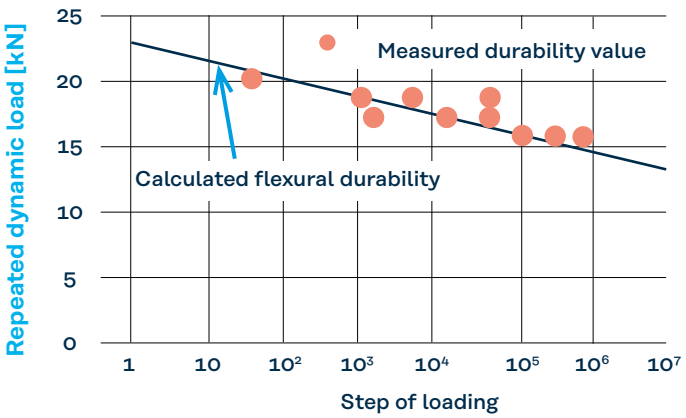
Plain concrete

Reference test standard; AASSHTO PP 34-99 ASTM C 1581

## Freeze-thaw cycle




## Durability under repeated dynamic load




The test results show that the flexural durability of PVA fiber reinforced concrete with KURALON™ RF 4000/30 mm-2,0 vol% increases exponentially with decreasing cyclic loading, which is mostly the same behavior as the theoretically calculated flexural durability provided by direct tensile testing.

An authority in Japan reported that the application of PVA fiber reinforced concrete roadbeds with KURALON™ RF 4000/30 mm - 2,0 vol% has a capability of withstanding more than 100,000 cycles of dynamic load with 13 times of a designated load value.

T. Takahashi, Railway Technical Research Institute Monthly Report, Sept. 2011

KURALON K-II™

# Design-oriented building application

## The most suitable synthetic fiber for Ultra High-Performance Concrete

KURALON K-II™

# Ultra high-performance concrete

High-tenacity KURALON K-II™ is produced by Kuraray's special spinning process. In addition to high mechanical properties, it has very good adhesion to cement materials and alkali resistance, which makes it an ideal fiber for Ultra High-Performance Concrete (UHPC) in the construction industry.

**Applications**

- Iconic PVA fiber-UHPC façades, solar shading, roofs
- PVA fiber for UHPC furniture

**Benefits**

- Design-oriented building materials
- Thin and lightweight
- Durable building materials with good affinity to cement
- Design flexibility with less chipping and cracking of building materials
- No rust stains

KURALON K-II™

# No limits for your design

Curved, decorative, thin, lightweight - precast concrete panels for façades, solar shading, roofs...

# Technical data to create UHPC for façades

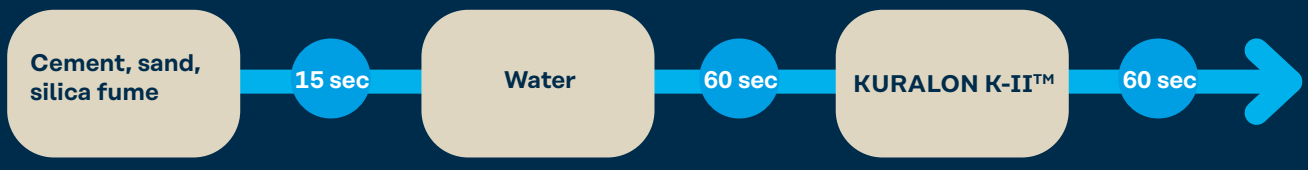
## Bending toughness of concrete with KURALON K-II™

Bending toughness is provided not only by macro fibers. KURALON K-II™ meso fibers, which have a diameter of around 200 microns, can work well as reinforcement, especially for the UHPC matrix. We conducted bending tests with KURALON™ meso fibers for the general design of the UHPC mix.

| Fiber | Diameter [μm] | Length [mm] | Density [kg/m³] |
|---|---|---|---|
| **KURALON K-II™ RF 400** | 200 | 12 | 1.30 |

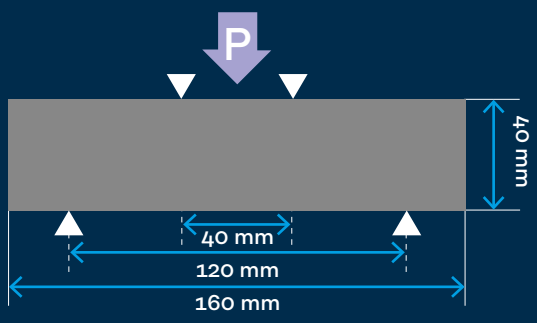
Diameter: value derived from the cross-section of the fiber and converted as if it were a circle.
This item has CE certification and
complies with EN 14889-2 for synthetic fiber for reinforcing concrete.

## Mixing procedure



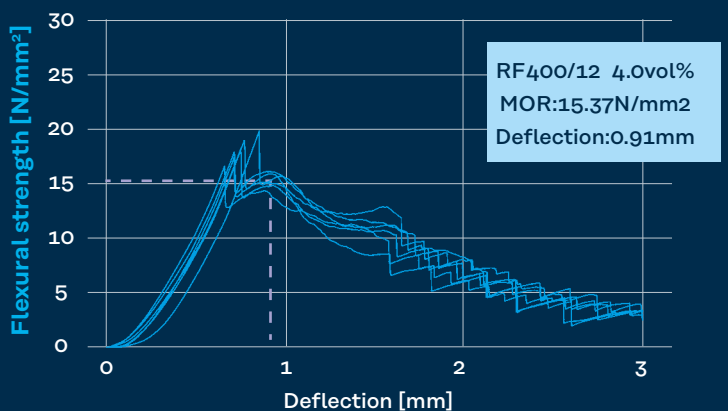

Demolding: 1 day after molding
Curing condition: 28 days after molding by underwater curing

## Bending test method




Test condition: Specimen size: L x W x D = 160 x 40 x 40 (mm)
Load speed: 0.2 mm/min

## Bending test results



# Adding value to your products – worldwide

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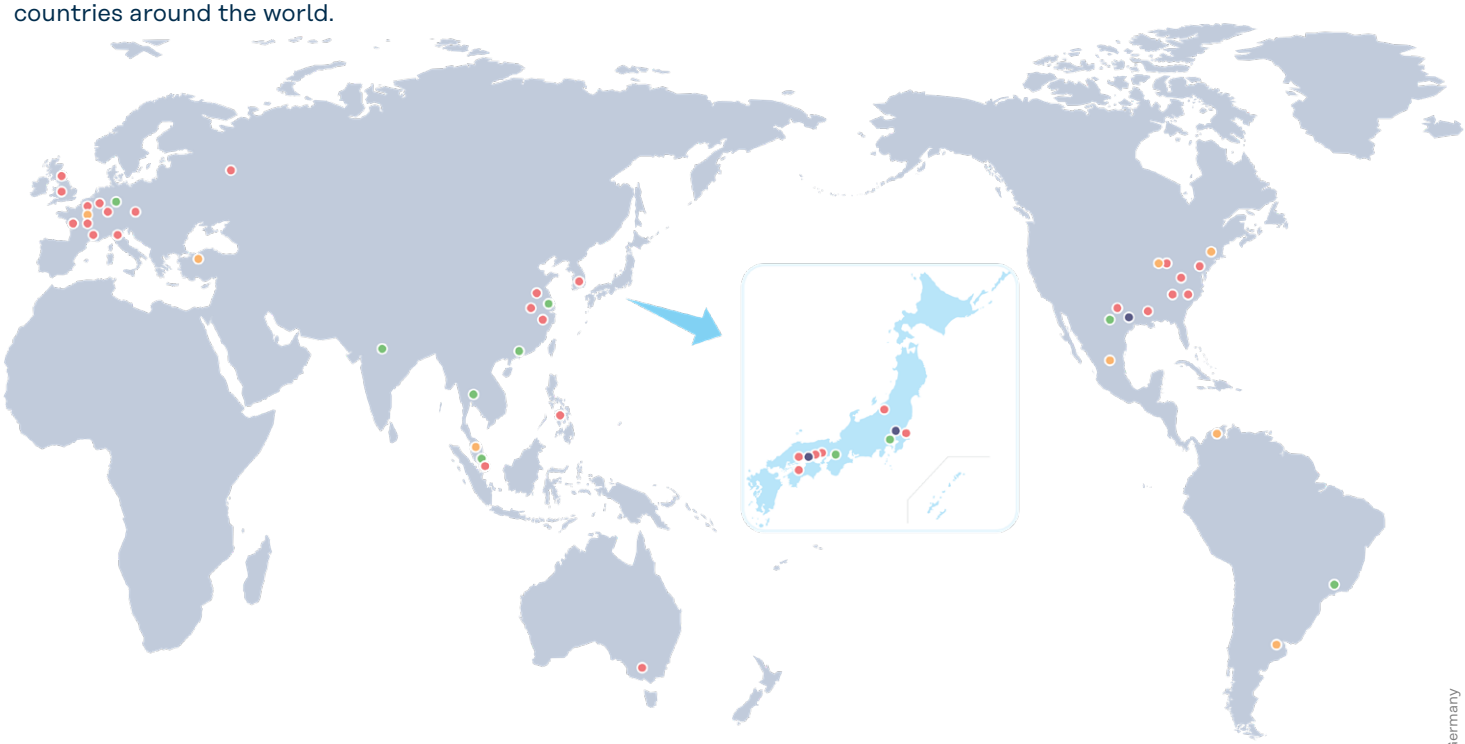
KURALON™

KURALON K-II™

Kuraray is a global speciality chemicals group based in Tokyo, Japan. It is one of the largest suppliers of polymers and synthetic microfibers and an international leader in the development and use of innovative high performance materials. The Kuraray Group has a network of 103 companies in 31 countries around the world.



- Kuraray head office and regional headquarters
- Kuraray plants
- Kuraray laboratories
- Kuraray major sales locations

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