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Quality and performance of polyvinyl alcohol fibers for durable constructions

جودة ألياف البولي فينيل الكحولي وأداؤها للإنشاءات المتينة

Kuraray is a Japanese chemical company, founded in 1926 as a Rayon manufacturer, and now operates globally. Kuraray offers innovative, sustainable and cutting-edge technology for numerous industries such as construction, automotive, packaging, agriculture and consumer goods all over the world. Kuralon is a synthetic fiber which is made from Polyvinyl Alcohol (PVA) resin. In 1950, Kuraray started its commercial production of Kuralon, which was the first synthetic fiber invented in Japan, and it has an especially long history in the cement composite market as a substitute of asbestos.

Kuraray هي شركة كيماويات يابانية، تأسست عام 1926 كشركة مصنعة للحرير الاصطناعي "الرايون"، وتعمل الآن على مستوى العالم. وتقدم شركة Kuraray تكنولوجيا مبتكرة ومستدامة ومتطورة للعديد من الصناعات مثل البناء والسيارات والتعبئة والتغليف والزراعة والسلع الاستهلاكية في جميع أنحاء العالم. والكورالون عبارة عن ألياف صناعية مصنوعة من راتنج البولي فينيل الكحولي (PVA). وفي عام 1950، بدأت شركة Kuraray إنتاجها التجاري للكورالون، وهو أول ألياف صناعية تُخترَّع في اليابان، ولها تاريخ حافل عريق بشكل خاص في سوق الأسمنت المُركَّب كبديل للحرير الصخري "الأسبستوس".

High strength, UV and alkali resistance make Kuralon an ideal material for durable and low maintenance concrete structures. Kuralon offers a unique combination of properties making it most suitable for concrete and mortar reinforcement:

- High Strength
- High Modulus
- Low Elongation
- Good adhesion to Cement Matrix
- Alkaline Resistance
- UV Resistance
- Light Weight
- No Corrosion

Kuralon RF4000x30 mm

The benefits of using PVA fiber for preventing the crucial deterioration of concrete structures

In conventional steel reinforced concrete a deflection of 4 mm at the top of a specimen causes a crack opening at the specimen's bottom side of about 100 μm (specimen size;100x100x350 mm). This is a critical value as capillary suction of a concrete surface starts to show a serious increase when its cracks exceed a width of 100 μm. The critical point is the very early post crack period. As soon as the first crack appears, moisture penetrates the specimen and causes long-term damage. It is therefore essential to control the crack as soon as it occurs. PVA fibers are predestined to actively control the early post crack period when it is most needed.

Kuraray´s PVA fiber, Kuralon, bridges and keeps the cracks very small – especially in the most important phase right after the crack. The advantage is that the probability of critical deterioration of the concrete structure is minimized. Sometimes this even helps self-healing. This performance would be worth considering if one desires to reinforce concrete structures under severe conditions such as high erosion risk from sea waves, drifting objects in offshore use, and high risks of structural deterioration by heavy dynamic load and anti-freeze chemicals on highways and airport taxiways.

Kuralon reinforced concrete strain hardens after first cracking and demonstrates a strain capacity 500 times greater than normal concrete. That ensures superior fracture toughness, damage tolerance and ductility under severe shear loading conditions. Kuralon helps to extend service life and drives sustainable investment decisions. [1]

Similar research and evaluations are conducted by Kuraray´s clients since this technology contributes to long-life sustainable construction with cost efficiency in long term.

Main application fields

The technology can be used for production of SHCC (Strain-Hardening Cementitious Composite) for road construction and 3D concrete printing.

Sustainability of infrastructure requires advanced materials. Kuraray's Kuralon micro PVA fibers enhance the functional performance of engineered cementitious composites (ECC) and extend service life. Bridge decks made with Kuralon reinforced ECC joint can have significant advantages in environmental and cost performance: 40% less life cycle energy consumption, 38% less raw material consumption, 39% less carbon dioxide and 50% less solid waste generation than bridge decks with steel expansion joint. [2]

3D printing has reached new dimensions and is setting new standards for the construction industry. 3D printed buildings enable innovative design, accelerate delivery and produce less construction waste. Kuraray's Kuralon is an ideal reinforcing fiber for SHCC used in 3D concrete printing.

UHPFRC stands for Ultra-High Performance Fiber Reinforced Concrete for envelopes and decorative esthetics like fine-decorative and cladding façade, solar shading, etc. Kuralon meso fiber is an ideal synthetic fiber to reinforce UHPFRC, and provides the following benefits to clients:

- Thin and lightweight with fine decorations and durability are available
- Rusty water doesn't come to the surface of construction materials

Formulations of UHPFRC with Kuralon meso fiber make it adaptable to a wide range of production techniques including shotcrete, traditional casting, 3D concrete printing.

LWAC stands for Lightweight Aggregate Concrete for non-structural use to form a level and more stable surface on which further works can be more readily undertaken, e.g. an inhibitory effect against erosion of substructure in offshore use such as a concrete support structure for offshore wind turbines.

If some inherent weaknesses of LWAC such as brittleness and low elasticity-modulus are improved, the floating LWAC support structure will be the best option. Kuralon macro PVA fiber can reinforce it and improve its performance.

Life Cycle assessment of bridge decks: Advantages of PVA-FRC over conventional systems [2] (Possible application)

By introducing Kuralon as a reinforcement of LWAC, the brittle failure resulting from the punching shear is improved, and the punching shear toughness will exceed conventional normal concrete. [3] Moreover, some research groups reported that Kuralon improves the fatigue resistance of LWAC against dynamic cyclic load, and shows approximately 11 times greater fatigue resistance than conventional reinforced concrete. [4]

References

[1] G.A. Keoleian, A. Kendall, R. Chandler, G.E. Helfand, M. Lepech and V.C. Li, Life cycle cost model for evaluating the sustainability of bridge decks.

[2] G.A. Keoleian, A. Kendall, R. Chandler, G.E. Helfand, M. Lepech and V.C. Li, Life Cycle Modeling of Concrete Bridge Design: Comparison of Engineered Cementitious Composite Linked Slabs and Conventional Steel Expansion Joints.

[3] Kishi et.al, PVA Effect of improving the puncture shear resistance of RC panels made of lightweight concrete by mixing short fibers, Annual Papers in Concrete Engineering, Vol. 28, No. 2, 2006.

[4] S. Adachi et al, PVA effect of improving the fatigue resistance of RC floor slabs made of lightweight concrete mixed with short fibers.

FURTHER INFORMATION

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