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Pioneering use of Duplex LDX 2101® in concrete reinforcement

The Gateway Upgrade Project, to duplicate a motorway bridge across the Brisbane River in Australia's Queensland, will use duplex LDX 2101® stainless steel reinforcement bar.

South-east Queensland is the fastest growing region in Australia. In order to meet the region's future demands and to secure its economic success, Brisbane's six-lane Gateway Bridge will be duplicated as part of the Gateway Upgrade Project. This is the largest road and bridge project in Queensland's history, delivered by Queensland Motorways with design and construction by the Leighton Abigroup Joint Venture. Looking to the future, the new bridge will have a design life of 300 years. To ensure such a long lifespan, the bridge design specifies stainless steel reinforcement bar (rebar for short) in the most critical bridge structures: The pile caps located in the splash zones of the two main river pylons of the Brisbane River. Positioned in the most aggressive environment of the entire structure, a 150mm thick stainless steel reinforced cover was formed around the structural steel, prior to casting of concrete. Construction of this cover plays a key role in reaching the 300 year design life specification, and the main span pile caps were the only area requiring use of stainless reinforcement steel." Gerry van der Wal, Alliance and Construction Manager.

Leighton Abigroup Joint Venture approached Outokumpu as they were searching for a stainless rebar supplier. The Outokumpu Group is one of the leading producers of stainless steel long products in the world and manufactures stainless rebar at its ASR Rod Mill and Sheffield Stainless Bar facilities in the United Kingdom.

Based on state-of-the-art knowledge of stainless rebar, the Joint Venture was looking for a product in the austenitic grade EN 1.4404 (ASTM 316L). Outokumpu felt they had a superior solution: The Group's Australian sales company suggested using duplex stainless steel of grade LDX 2101® instead. The corrosion resistance of this proprietary Outokumpu duplex grade is close to that of 1.4404. However, LDX 2101® does the task with very low nickel, making the duplex grade highly competitive to austenitic grades.

Pile cap with stainless steel reinforcing "cover" visible

LDX 2101® had never been used in rebar before. So the bridge engineers had the question, would the grade have the required corrosion resistance for the extended period of time? Outokumpu's in-house research metallurgists had made extensive corrosion tests on LDX 2101® rebar in the event that concrete is permeated by seawater. The results prove that LDX 2101® withstands such a high corrosion environment.

For additional proof of the advisability of the Outokumpu concept, ASR Rod Mill sent a trial rebar coil to Atlas Specialty Metals in Melbourne for further processing to confirm that LDX 2101® coil could be easily straightened.

As a result of the research and tests, the second Gateway Bridge was constructed using LDX 2101® rebar.

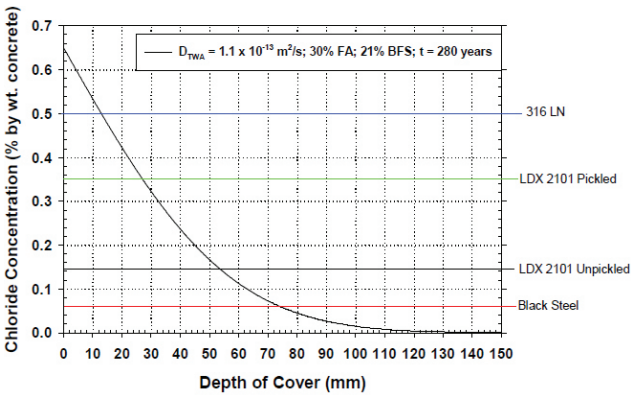
Why and how to use stainless rebar

In the United States, corrosion is estimated to cost close to US$ 300 billion per year, eating away 3-4 percent of GDP. As much as 40 percent of this is preventable.

Stainless steel rebar has been around since the 1930s, but an overwhelming majority of concrete reinforcement is still made using carbon steel. Instead of reinforcing concrete, carbon steel rebar can do exactly the opposite: if humidity manages to ingress the structure, the rebar swells as it corrodes resulting in cracking in the concrete. The corrosion process is made far worse by chlorides from either atmospheric sources or de-icing salts on roads. In recent years, a large number of reinforced concrete structures have shown early signs of deterioration. Bridges have been closed for maintenance after as little as three or four years in service.

Richard Goodman, representing Outokumpu's stainless-rebar technical expertise, speaks about the proper use of stainless steel in bridge construction. He does not advocate building all-stainless structures, saying, "Stainless steel should be specified selectively for parts where it makes a positive contribution." These parts are in splash zones and the bridge deck. If carbon steel rebar is used, the bridge deck needs a water-proof membrane, and concrete must be of high quality. If stainless rebar is used, reduced concrete cover can be specified, and it is also possible to relax the design criteria with respect to maximum crack width. Mr. Goodman states, "With stainless rebar, bridges can be built either with no extra cost or for a lower cost than by using carbon steel reinforcement."

Today LDX 2101® offers the most cost-effective alternative for durable reinforced concrete structures. Due to its good price stability, LDX 2101® offers construction projects vitally important predictability. The win-win outcome from the use of LDX 2101® rebar is a cost efficient, much improved sustainability in our constructed environment.



Predicted Chloride Profile at Year 280 (Pile Caps, Grade S50 Ternary Blend Concrete). Corrosion threshold for black and stainless steels indicated.

Project details:

Gateway Bridge duplication, as part of the Gateway Upgrade Project, Brisbane, Queensland, Australia. Completed in 2011. (First bridge completed in 1986.)

Contractor:
Leighton Abigroup Joint Venture

Bridge details:
Bridge type: balanced cantilever motorway bridge
Main span: 260m
No. of lanes: 6

Outokumpu's supply:
Over 200 tonnes of duplex LDX 2101® stainless steel reinforcement bar, hot rolled, ribbed, 12 and 16mm in diameter. Supplied in coil form. Used in the splash zones of pylons.

Processing of coil:
Straightening and cutting to length at Atlas Specialty Metals, Melbourne, Australia

Background and project details:
Since the opening of the Gateway Bridge and Motorway in 1986, the population of south-east Queensland has grown rapidly. A new and bigger airport has been built, the Port of Brisbane has seen significant increases in shipping, and new industrial ventures have been established. Just over 20 years since its opening, the Gateway Motorway is now exceeding capacity, carrying more than 100,000 vehicles each day.

Project involves:
- Upgrade to 12km of the Gateway Motorway from Mt Gravatt-Capalaba Road to Lytton Road, and
- Construction of a new 7km Gateway Motorway deviation, providing a more direct route north of the river and better access to Brisbane Airport.

Other information:

For more information on stainless and LDX 2101® rebar, contact:

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Working towards forever.

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: clean energy, clean water and efficient infrastructure. Because we believe in a world that lasts forever.

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