PORT OF NAPIER DEBUTS HIGHLY MODIFIED ASPHALT

Authority replaces container wharf pavement damaged by forklift loads in world's first commercial use of high-performance asphalt base course.

By **Paul Fournier**

New Zealand's Port of Napier recently repaired a heavily deformed section of pavement in their Container Terminal by replacing the failed pavement with high-performance asphalt mix incorporating technology never before used in a base course anywhere in the world.

Local contractor, Higgins Contractors Limited (HB), of Napier removed the deformed pavement from a section of H8-K1 and re-paved the area using Highly Modified Asphalt (HiMA) technology developed by Kraton Polymers LLC. The technology employs hard bitumen modified with styrene-butadiene-styrene (SBS) polymer, Kraton™ D0243, and is designed to improve pavement resistance to permanent deformation and fatigue from repetitive loading.

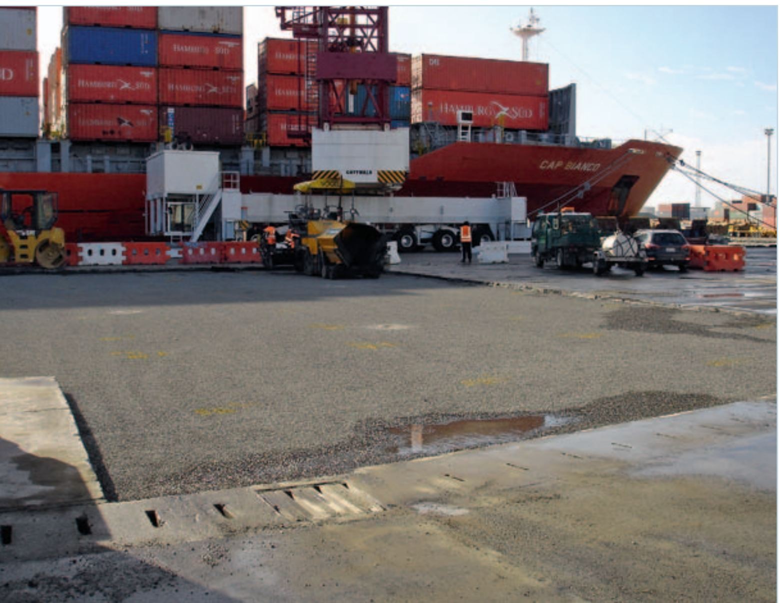
Such pavement qualities are essential at the section near the edge of Kirkpatrick Wharf (Wharf No. 5) where forklifts loading and unloading shipping containers have imposed extraordinary repeated loads that caused premature failure of the pavement. The section of the pavement was originally built as an access road, and the pavement, built in 2001 and 2002, was never designed to accommodate channelised container-handling wheel loads with typical front-axle loads of 110 tonnes.

As mix cooled rapidly in the raw weather, the crew operated the Sakai pneumatic-roller in vibratory mode to expedite compaction.

Damage from rising container traffic

Adding to the problem is the fact that the number of containers passing through the Port of Napier, which is owned by the Hawke's Bay Regional Council, has substantially increased in recent years due to its favourable east coast location near the main New Zealand shipping lane. Operating 24 hours a day, seven days a week, Napier is the primary export seaport for central New Zealand.

The increasing number of container throughputs at Port of Napier exacerbated pavement damage, requiring the use of more robust asphalt mix.



Commenting on the pace of container operations at Napier, Clarke Curtis, Senior Engineering Technician for the Port of Napier, estimated that over the past 10 years container throughputs at the port have approximately doubled. Mr Curtis pointed out that shortly after the road was built, forklifts began using the area as a dogging station where container twist locks are either removed from import containers or placed on export containers. He said this operation requires the forklifts to repetitively arrive at very low speeds with hot tyres, grind to a halt and then slowly accelerate and turn on the spot.

Within a few years, pavement damage from this activity became visible with the appearance of deep ruts. Depressions up to 85mm deep were measured in the wheel paths, with deformation in the basecourse alone exceeding 40mm. Furthermore, ruts were causing forklifts to shake, requiring the Port of Napier to spend more money on maintaining them, Curtis said.

Port officials decided to have the pavement reconstructed, but they wanted a pavement that could stand up to the punishment imposed by high forklift axle loads over a pavement design life of 20 years.

Officials agree to HiMA trial

At a meeting with Higgins Group, which has a long history of performing construction in Napier, port officials were asked to approve the trial of HiMA for the H8-K1 project. Sean Bearsley,

Product Development Manager for Higgins Laboratory, viewed the small, 400-square-metre project as an opportunity for Higgins Group to demonstrate the capability of HiMA technology. Additionally, he said the trial would provide Higgins Group valuable experience with promising technology that could have major ramifications for pavements subjected to heavy loads or pavements with asphalt layer thickness limitations.

Port officials agreed to try out the technology for the H8-K1 pavement replacement, using a pavement design created by Robert Patience, Higgins Group Technical Manager. According to Mr Curtis, one of the reasons they agreed to the design tryout by Higgins is that it meant they did not have to dig as deep and get into the water table compared to the original design.

And they also have good access to bitumen and stone with a quarry nearby. He said many ports do not have this advantage.

Improving pavement design

First, Higgins tried out the new asphalt mix on its own property to acquaint the paving crew and technical personnel with handling and other properties of the new product. In September, Higgins executed the H8-K1 project. They removed the deformed section and re-paved the area, applying HiMA technology in the base course and standard SBS-modified mix for the surface layer.

The original pavement structure consisted of 250 mm of 0/65-mm river gravel subbase over a marine gravel subgrade, 500 mm of crushed 0/40-mm aggregate stabilised with 2% Portland cement, and 100 mm of Mix 20 asphalt surfacing made with unmodified 80/100 bitumen.

This was replaced by a new pavement structure designed by Patience calling for 750 mm of 4.5% Portland cement stabilised 0/40 crushed aggregate subbase, 100 mm of SP28 high modulus base course made using Kraton™ D0243 modified bitumen 40/50, and a 50-mm SP14 surface course made using 5% SBS modified 80/100 bitumen.

Patience pointed out the base course design is essentially identical to a Superpave 25 with the exception that a slightly larger aggregate was used – a 26.5-mm nominal maximum sieve instead of 25.0-mm. All of the aggregate was greywacke. The design was a continuous well-graded mix using six single-sized crushed coarse aggregate components, and one fine aggregate comprised of crusher fines or dust. No natural sand was used.

More polymer made possible

The content of the 40/50 penetration grade bitumen for the base course was formulated to be 4.3% of the mix mass, with Kraton D0243 polymer comprising 7.5% of the bitumen. Until the development of the low-viscosity D0243, such an elevated polymer content would not have been practical.

While adding polymer to bitumen provides desirable benefits, traditionally the modification level has been limited by workability and compatibility. Generally, as polymer content in bitumen binder exceeds 3% the viscosity of the binder begins to increase, making asphalt mix gradually more difficult to produce in the plant and increasingly unworkable at the job site. The level of mix stiffness that plant operators and paving crews are willing to tolerate depends on historical local preferences. In New Zealand, general practice has been to use between 2.5 and 5.0% SBS when polymer is specified.

Also constraining modification levels is the tendency of highly modified hard binders to segregate in unstirred storage, making the binder unusable. In addition, while standard modified binders are typically based on 80/100 bitumen, the use of the harder 40/50 base bitumen would affect workability and compatibility, further limiting the maximum polymer concentration.

However, through changes in polymer design, Kraton™ D0243 polymer content can be raised well beyond 6% – even in harder bitumens. At the selected 7.5%, no adjustments were needed at the plant or in the field to accommodate the blend for the H8-K1 project. The new polymer minimises viscosity increase, yet substantially improves resistance against permanent deformation and resistance against fatigue from repetitive loading compared to standard high-performance binders, according to Kraton researchers. These benefits afford pavement designers a choice – they may opt for longer pavement service or reduce pavement thickness and save costs.

Installing high-performance mix

On the day that Higgins paved H8-K1, the weather was damp and chilly, with ambient temperatures hovering about 8°C and winds of approximately 30 kilometres per hour exacerbating conditions. Since Higgins' asphalt plant is located just six kilometres from the job site, there was no discernible drop in mix temperature as trucks delivered the material to the job site. At the wharf, the trucks deposited the 160°C asphalt directly into the hopper of Higgins' Vogele paver. The relatively small amount of asphalt needed for the trial project did not justify the use of a shuttle buggy.

According to Higgins' Patience and Bearsley, mixing, paving and compaction went smoothly. They indicated that the asphalt mix team observed an unusually clean operation compared to standard SBS modified binders with no strings hanging from the belts.

Furthermore, they did not notice much difference in handling the high-performance base course mix in comparison to asphalt employing standard SBS modified bitumen. However, they observed that as the mix cooled rather quickly due to raw weather – from 160°C in the paver to 100°C in the pavement in just 30 minutes -- hand work became more difficult. Compaction was accomplished by two 2X7-tonne double drum steel rollers and a pneumatic rubber-tyred roller. The latter, a Sakai GTW-750, was operated in vibrating mode to improve consolidation of the mix and achieve the specified 4% air voids. The crew commented on the resilience of the mix when the rollers went over it, saying it rebounded like rubber.

The proof of performance

A few months later, an opportunity arose for Higgins Group to pave another, larger, area of pavement – this one covering an area of approximately 2700 square metres at Loading Zone 1. The same type of mix was placed here as at H8-K1.

Bearsley said the proof of performance of the two re-paved sections would be simple –the absence of pavement wheel path deformations over time. He is confident the debut of HiMA technology in New Zealand will prove this high-performance asphalt mix to be the solution to the problem of pavement damage caused by very heavy loading, such as that experienced at ports, industrial areas, mining roads and motorway sections.

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