Category 3: Excellence in Sustainability and Innovation

WA Pacific Freight Terminal, Roadway F, Foamed Bitumen Stabilised Intermediate Course

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HIWAY

HIWAY

2024 AustStab Awards of Excellence

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Overview and Objectives

- Hiway Stabilizers and Fulton Hogan worked in collaboration to rehabilitate 850m in length by 10m wide of existing pavement located at the Pacific Freight Terminal, Kewdale on Roadway F.
- Kewdale Freight Terminal is a large intermodal rail facility in the Perth suburb of Kewdale, Western Australia, just south of Perth airport.
- Branching off the Kwinana freight railway, it was built in the 1960s to replace the Perth marshalling yard.
- Client sought early contractor engagement to develop concept treatments that met the following constraints of the project:
  - Budget
  - Improve Roadway F operating condition using rehabilitation treatments for renewal.
  - Retain as much of the existing pavement material.
  - Limit the amount of material that was sent to off site spoil location.
  - 30-year structural design life.
- Identified in the concept stage Foamed Bitumen Recycling (FBR) could be a suitable option. FBR has been used in limited applications to date for Port Pavements. Historically, heavily bound cement base layers overlaid with Asphalt have been the preferred and proven treatment options.

Overview and Objectives

- The pavement rehabilitation addressed pavement cracking, spalling, rutting, deformation(rutting and shoving), settlement, poor surface condition (oxidation/ravelling, flushing and delamination), potholes and patching.
- The pavement's structural analysis and rehabilitation design were undertaken using the AfPA Guide to the Structural Design of Flexible Pavements for Ports and Container Terminals 2021.
- The popular and long-established "The Structural Design of Heavy-Duty Pavements For Ports and Other Industries Edition 4", known as "The BPA Manual, was not used for the analysis of the pavement for two reasons;
  - The subgrade conditions on the site are significantly different from the pavements used in the development of "The BPA Manual" (CBR>15 vs CBR<5) and,
  - The methodology and recommendations within "The BPA" do not adequately cover Foamed Bitumen Base (Recycling), the primary candidate material and the structural layer selected at the close of the concept design stage.

Managing Risk

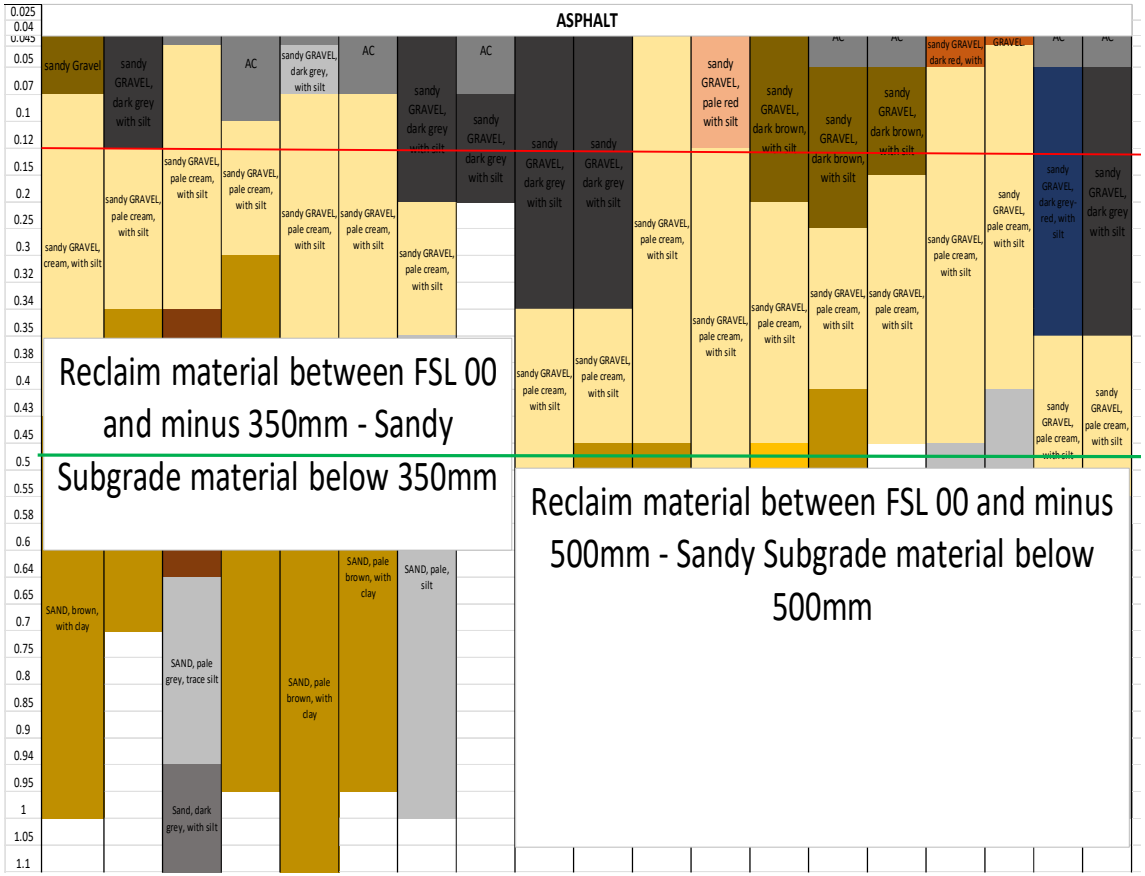
- Identified risks during the design phase:
  - Safety
  - Environmental
  - Financial
  - Material suitability
  - Contractual
  - Construction
- On completion of identifying risks they were then ranked.
- Each risk category was assigned to be managed.

Geotechnical Assessment

- For the section of 850m nominated for rehabilitation a detailed geotechnical field and laboratory investigation was carried out.
- A total of 9 Bore Holes were drilled to a depth of 1.5m
- A total of 10 Test Pits were excavated to a depth of 600mm.
- Design team interrogate data and define suitable treatment options to be assessed using FBS mix design process.
- Design team faced challenges with completing laboratory testing in a timely manner. This was due to a high workload within Western Australia.

Detailed Material Assessment Reviewed Against Pavement Design

- The pavement was divided into two sections, based on the depth of the existing material.
  - Section 1 - CH00 – 350
  - Section 2 – CH350 – 850
- The sections were also divided based upon the material properties confirmed by laboratory testing.
- Unbound granular base material tested exceeded nominated grading limits, in particular on the lower sieve sizes, fine material.
- Section 1 required the inclusion of subgrade material to achieve the pavement design.
- The inclusion of and subgrade material is required to eliminate the need to excavate out the unbound granular material.



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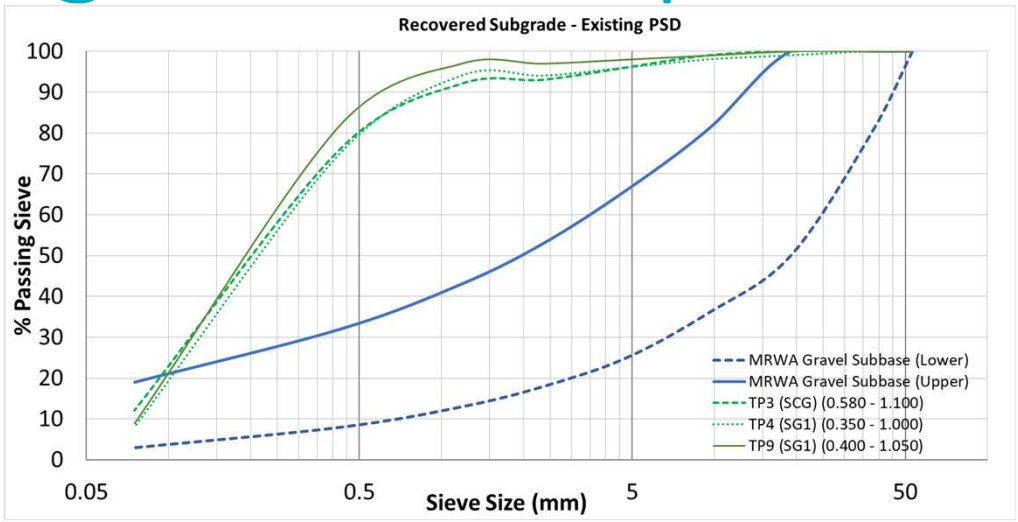
Preliminary Foamed Bitumen Mix Design Assessment

- The Constructed Foamed Bitumen had to achieve a minimum modulus of 2000MPa (soaked) – 7 day cure.
- Preliminary Foamed Bitumen mix design was undertaken to confirm if the minimum construction modulus might be achieved with the insitu material. Material assessed against MRWA Specification 501 Pavements – Gravel Subbase.
- Having a tight design phase, the preliminary mix design was necessary to get an understanding of how the material would respond to a foamed bitumen treatment.
- The table below is a summary of the preliminary mix design testing results providing data to assess if imported granular material would be required to be added in the mix design phase to improve the modulus.
- 3-day cured modulus was select to assess the results to expediated the testing and allow design activities to continue, this was also used to determine if asphalt placement needed to be delayed.

Source Material	Bitumen Content %	Cement Content %	3-day cured modulus (MPa)	3-day cured and soaked modulus (MPa)	Average retained 3-day cured modulus (%)
TP8 (Subbase)	3	1.5	1800	1100	61
TP2 (Base)	3	1.5	2800	1650	59
TP2 (Base)	3.5	1.0	1450	850	59

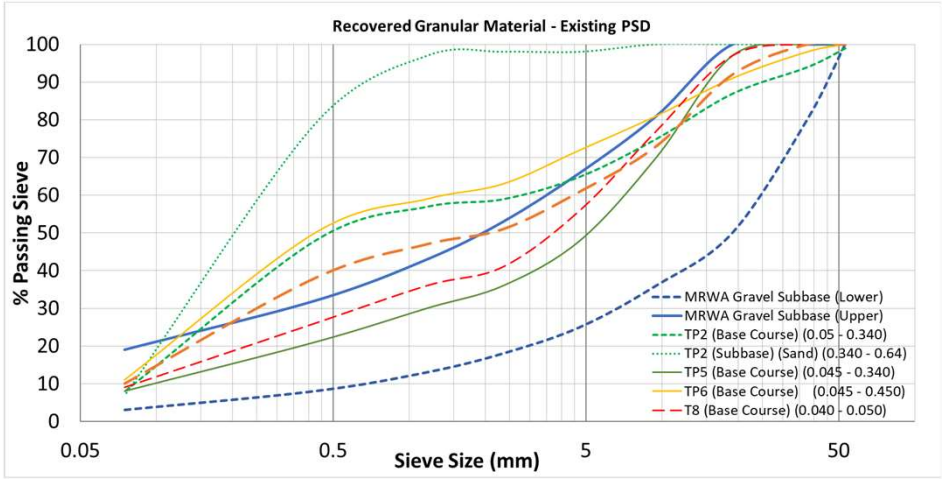
- It was determined that 3% bitumen binder and 1.5% secondary binder (cement) were the most suitable combination for the host material and mix design testing should proceed.
- Additional mix design testing would proceed, using a blended materials from TP2 and TP8, including importation of quarried granular material to improve the gradings.

Detailed Material Assessment Reviewed Against Concept Pavement Design



- Recovered granular material graph on the right reports the gradings of the tested material.
- TP2 included a subbase with a very fine grading, similar to the subgrade material, hence it was considered to be a subgrade material.

- Subgrade material had fine grading and being a clean sand was considered for inclusion in the FBR layer.
- This would be confirmed during the mix design process.



- The conclusion was that additional imported granular material would be required to improve the grading curve to fit within the grading limits. This equated to be 20% and 25% for Section 1 and 2 respectively.
- The incorporation of the imported quarried granular was deemed necessary to ensure the minimum 7 day cured modulus of 2000MPa would be achieved.

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Foamed Bitumen Design Outcomes

- On completion of the assessment of the materials four blends were identified as being required. The blends were referred to as Packages.
- Of the four packages two were selected, Package 1 and 4, these meet the minimum requirements for design modulus as these represented the blends that could be achieved onsite.
- The blends for Packages 2 and 3 were undertaken to determine if imported quarried granular material could be eliminated.

Mix Design Reference	Location	Bitumen/ Cement content %	Blend Composition	Initial Modulus (MPa)	3-day cured modulus (MPa)	3-day cured soaked modulus (MPa)	7-day cured modulus (MPa)	7-day cured modulus (MPa)	3-day UCS (MPa)	7-day UCS (MPa)	Selected Construction
Package 1	TP8	3.0/1.5	80% TP8 Base + 20% Imported Granular	1400	3500	2250	4250	2500	0.6	0.8	Selected
Package 2	TP8	3.0/1.5	60% TP8 Base + 40% Imported Granular	2000	3750	1250	5000	3750	0.9	1.1	Not Selected
Package 3	TP2	3.0/1.5	50% TP2 Base + 50% TP2 Subgrade	1300	2500	1250	3500	1750	0.2	0.3	Not Selected
Package 4	TP2	3.0/1.5	25% Imported Granular + 25% TP2 Base +50% TP2 Subgrade	-	3000	4000	4000	2000	0.6	0.7	Selected

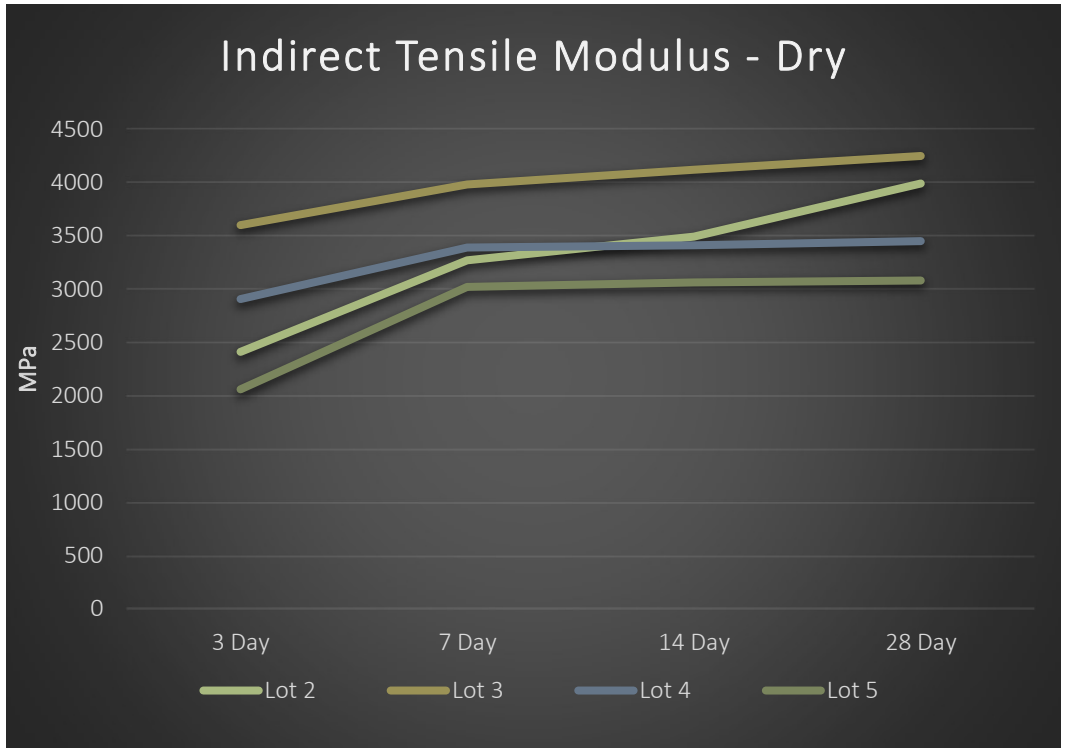
Construction Process

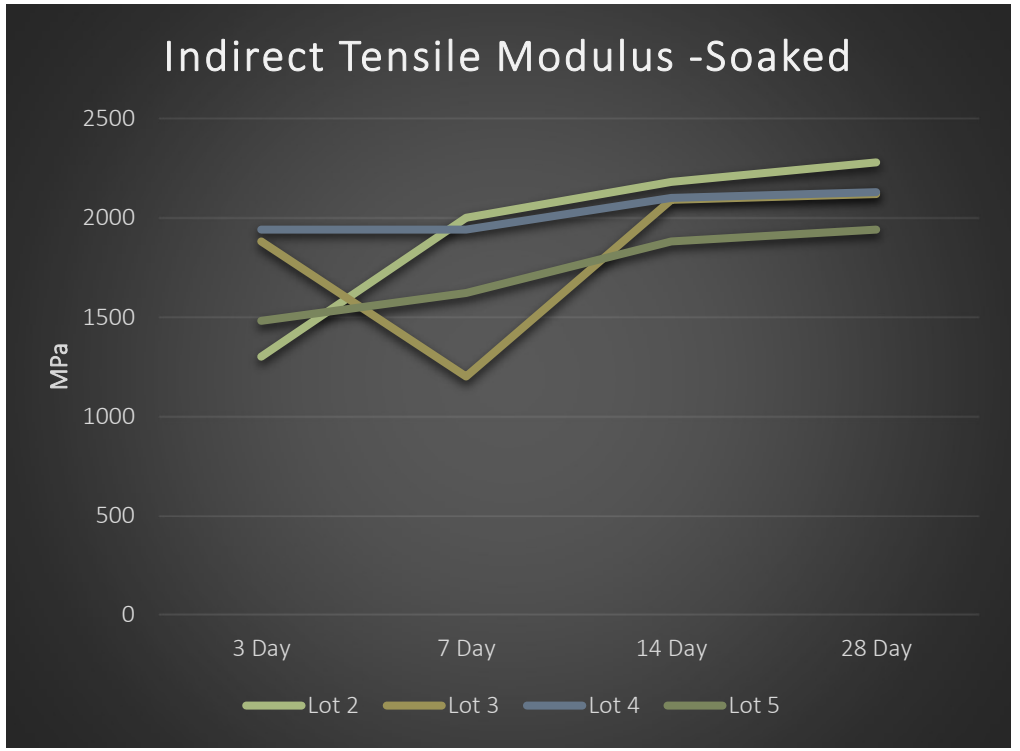
- Prepared detailed ITP's for construction.
- PFT Client versed in stabilisation and impressed with all works undertaken.
- Works carried out in 4 lots.
- Works completed on time and in budget.
- Client saw this project as successful due to:
  - Collaboration in design.
  - Construction was completed with no incidence and high quality work.
  - Limited the amount of material sent to spoil.
  - Limited the imported amount of quarried material.

- Achieved the FBS modulus during construction for lots.

Construction Modulus Results

- During the design phase it was agreed that 3, 7, 14 and 28 day modulus testing would be undertaken on the constructed FBS material. This was agreed as the pavement would be delayed in trafficking and allowed the FBs layer to gain strength, this was identified early in the design phase.





Material Savings

Section 1 - CH 00 – 350

- For this Section 20% of the insitu material needed to be excavated and replaced with imported quarried granular material.
- Data used to calculate tonnages as reported on laboratory test reports.
  - Insitu MDD = 1.77t/m^3
  - Imported Granular Material = 2.1t/m^3

FBR Treatment Depth (350mm)	Material to be Excavated for 20% Replacement (70mm)	Imported Material for 20% Replacement (70mm)	Import Granular Tonnages saved (280mm depth)	CO_2e Saved (kg)
350mm	1053 tonnes	1250 tonnes	4998 tonnes	111,163

Section 2 - CH 350 – 850

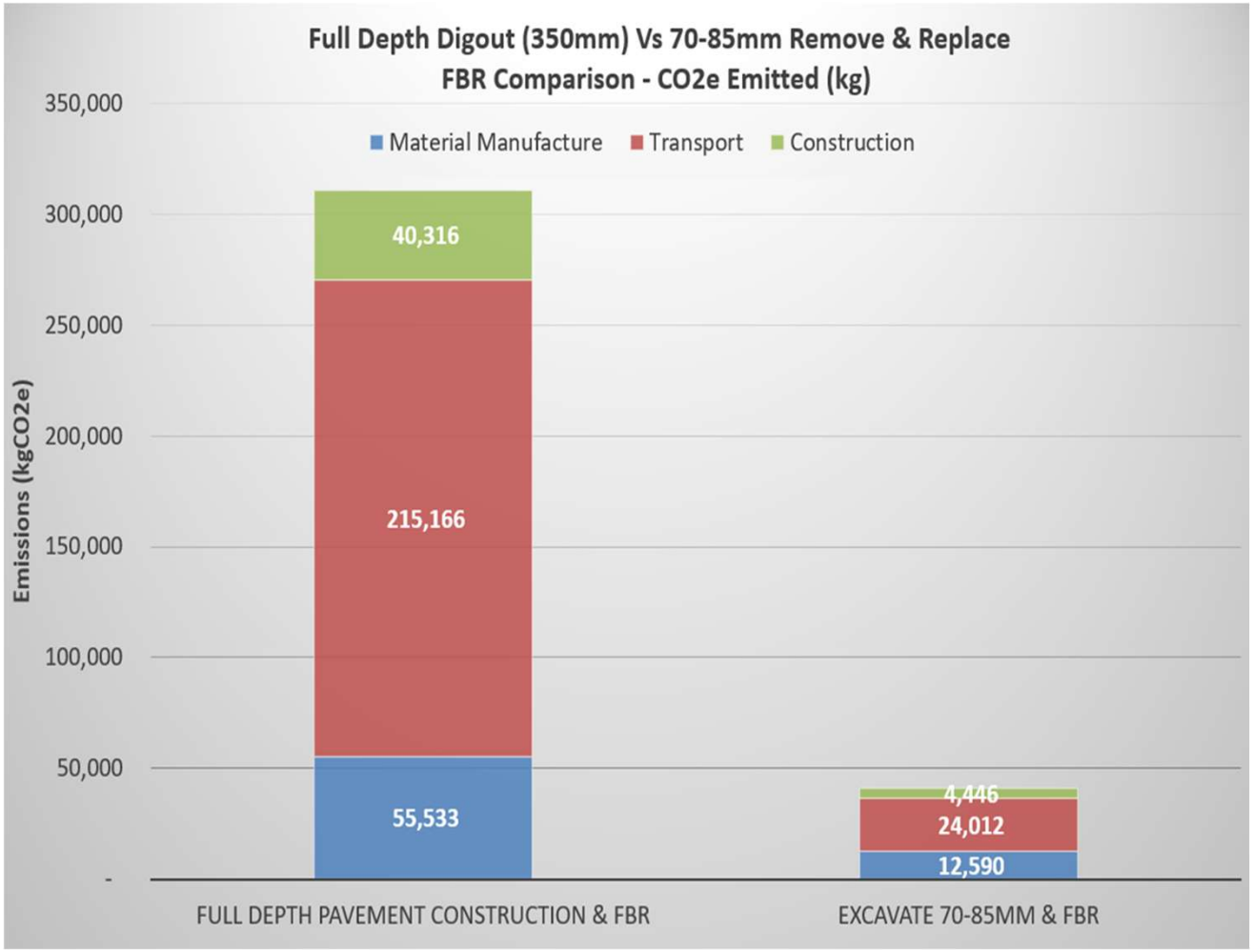
- For this Section 25% of the insitu material needed to be excavated and replaced with imported quarried granular material.
- Data used to calculate tonnages as reported on laboratory test reports.
  - Insitu MDD = 1.97t/m^3
  - Imported Granular Material = 2.1t/m^3

FBR Treatment Depth (350mm)	Material to be Excavated for 25% Replacement (85mm)	Imported Material for 25% Replacement (85mm)	Import Granular Tonnages saved (265mm depth)	CO_2e Saved (kg)
350mm	1424 tonnes	1517 tonnes	4730 Tonnes	158,804

Carbon Calculation

Based on:

- Comparison of remove all poorly graded material and replace vs. remove 70-85mm material to adjust grading
- Transport cut to waste 35km to dump site
- Import new granular material 30km from quarry
- For the purposes of this exercise – FBR emissions excluded as these are very close to like-for-like



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Ongoing Performance

- FBS provided a solid working platform to construct asphalt layers.
- Pavement been in operation for 1 year with no defects observed.
- No remediation works required during the defects liability phase.

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