Bonneagar Iompair Éireann
Transport Infrastructure Ireland

DN-PAV-03021 Analytic Pavement & Foundation Design

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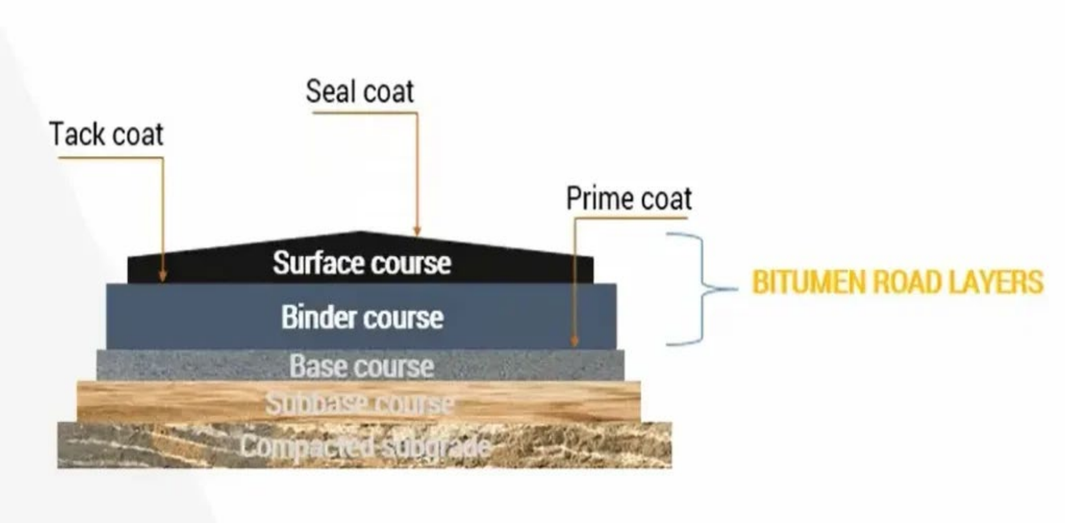
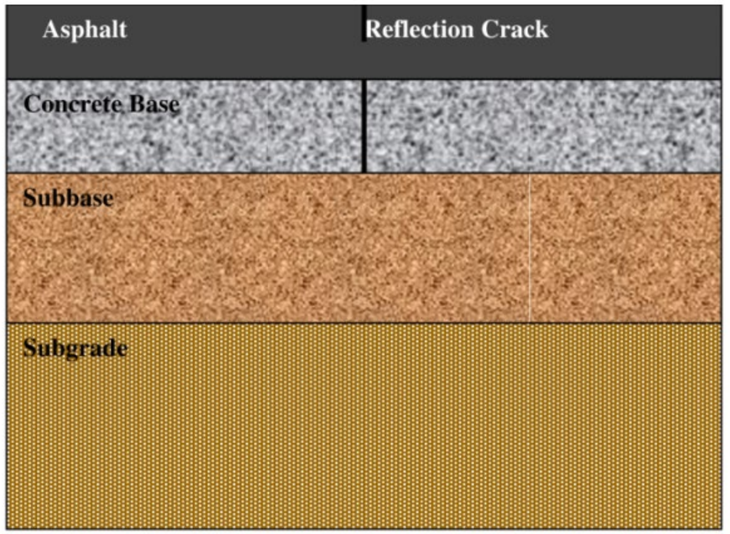
Introduction to DN-PAV-03021

- This document will guide a pavement designer through the design process for new pavements and the strengthening of existing pavements.

- The design of flexible and flexible composite pavement types only are considered within this publication





TII's Sustainability Implementation Plan

Provide effective, efficient and equitable mobility

Enable compact urban growth and regional accessibility through networks and services that support more efficient journeys, more effective connectivity and increased accessibility.

Enable safe and resilient networks and services

Enable safe, secure, accessible and inclusive travel through the provision of transport networks, systems and services that are resilient to future change.

Collaborate for a holistic approach

Develop smart and sustainable assets and services through innovating and improving the planning, design, construction, operation and maintenance of the transport network, increasing collaboration and systems-thinking to seek mutual gains and mitigate negative externalities.

Deliver end-to-end improvements

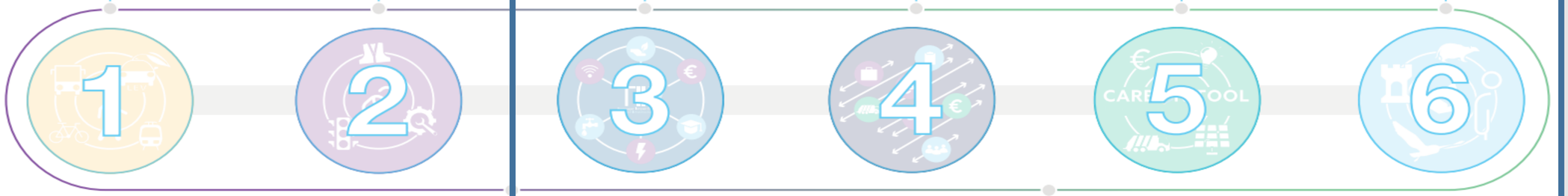
Deliver enhanced whole life-cycle value through impact and influence on stakeholders, partners and suppliers.

Transition to net zero

Reduce the carbon impact of construction, operation and use of the transport network through responsible use of resources, reuse and repurposing, as well as driving the net-zero transition and enabling customers to make more sustainable choices.

Create total value for society

Maintain and enhance the balanced delivery of economic, environmental and social value through robust planning, rigorous appraisal and decisions that prioritise sustainability.



Leadership, Collaboration and Partnership

Working Together and Enabling People

Significant updates to the document

- The new document introduces the Irish Analytic Pavement Design Method (IAPDM) software
- Pavement designs will be carried out using IAPDM web-based software.
- Capabilities to analyse new construction pavements and existing pavement strengthening options.
- IAPDM allows the consideration of actual material performance characteristics

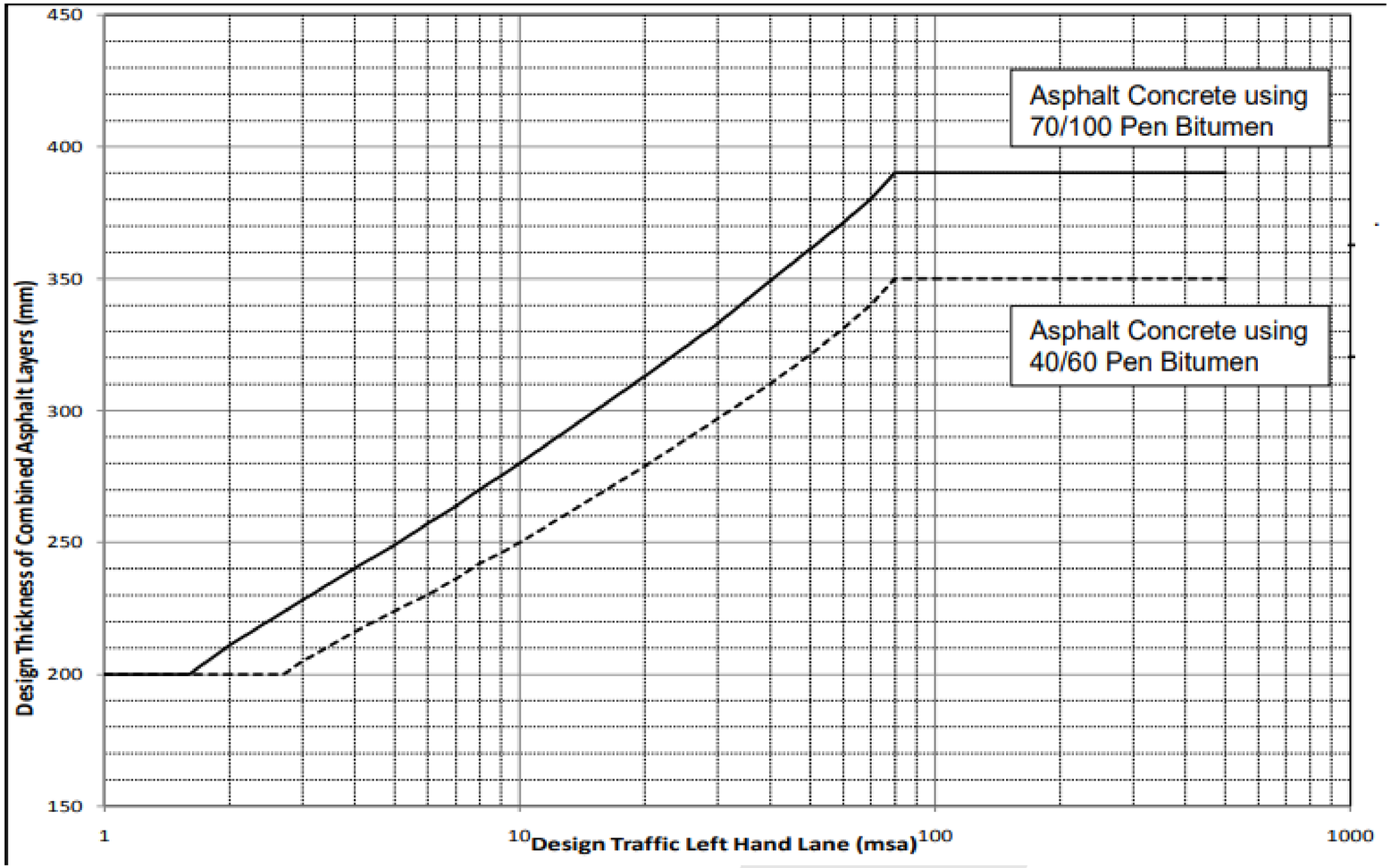
Why a change was necessary

DN-PAV-03021(December 2010):

- TRL Report LR1132 (1984)
- TRL Report 615 (2004)

- Restricted materials

- Materials, production and construction from 38 years ago



New Pavement Design Process (NPDP) - Part 1

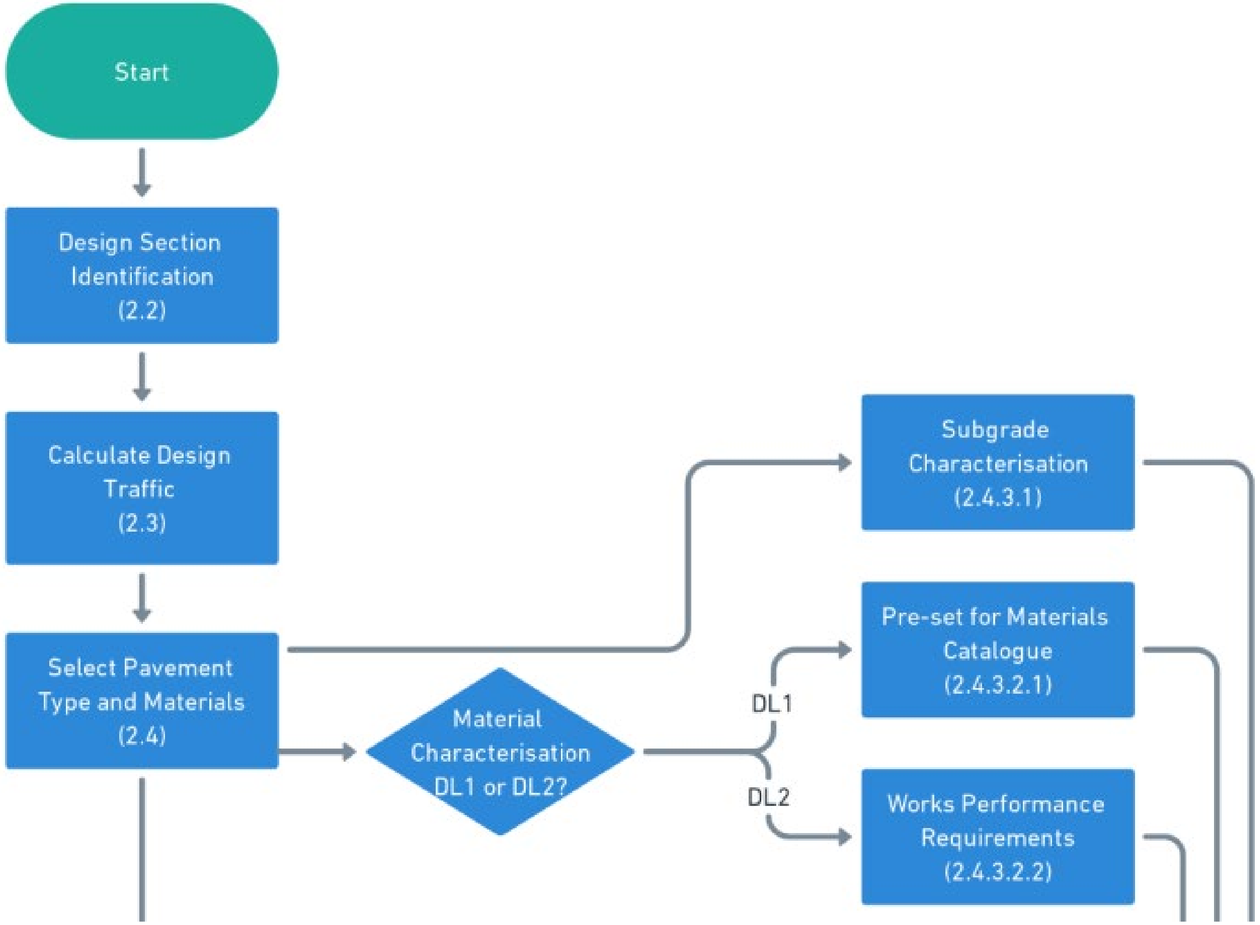


Figure 2.1 New Pavement Design Process

New Pavement Design Process (NPDP) - Part 2

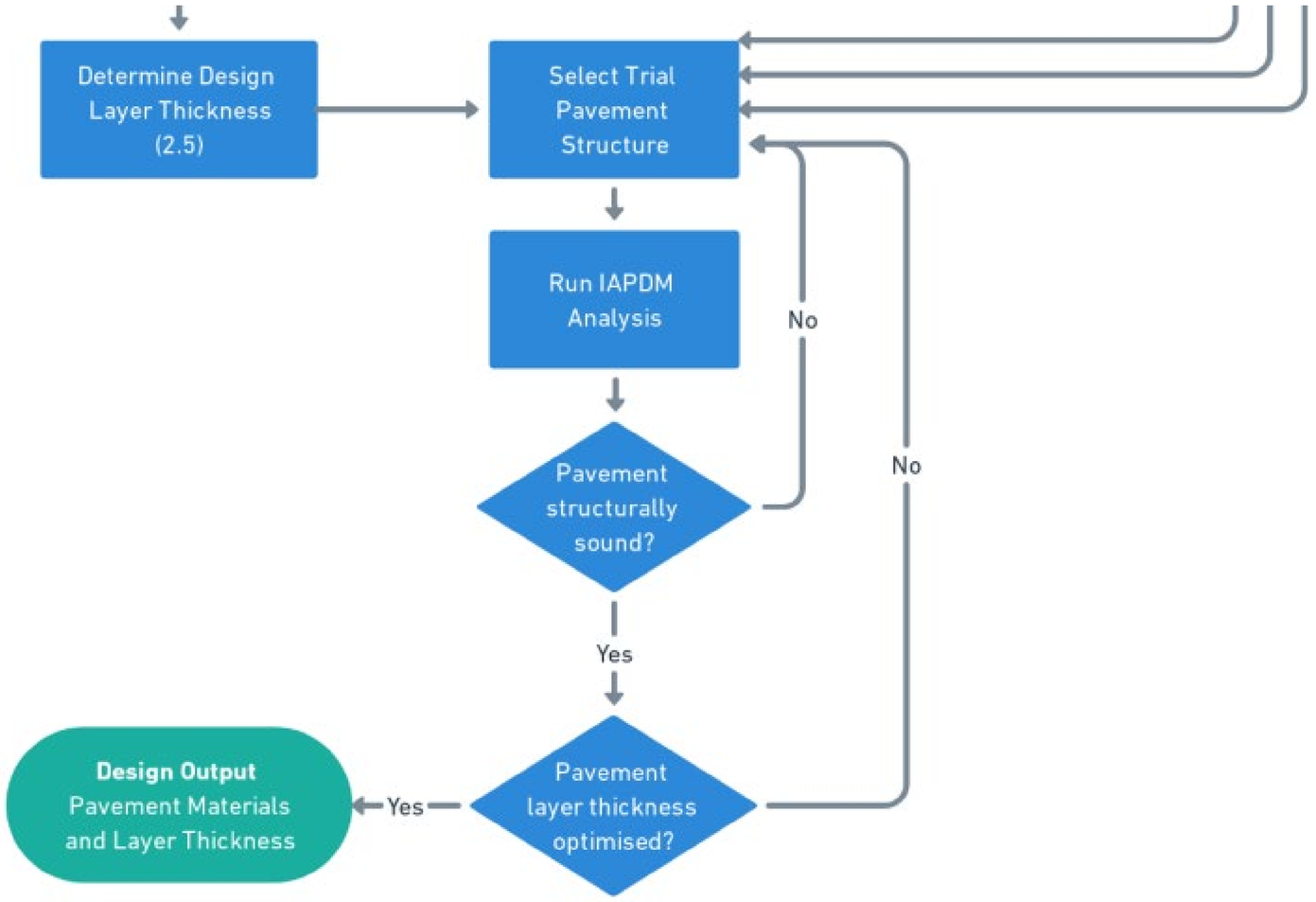
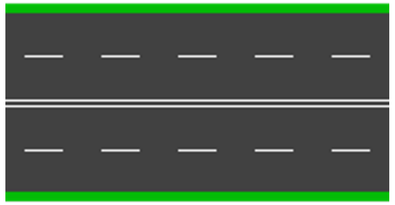


Figure 2.1 New Pavement Design Process

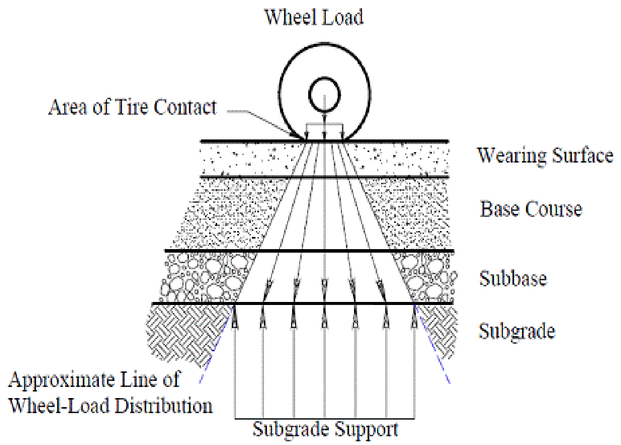
NPDP Step 1 - Design Section Identification

- The start and end chainages of design sections for new pavements are to be defined based on the following conditions:
  - Lane configuration
  - Traffic Loading in design lane / most heavily trafficked lane
  - Subgrade design stiffness

Single Carriageway with 2 lanes



Single Carriageway with 4 lanes



NPDP Step 3 – Select Pavement Materials

The aspects that should be considered by the designer when considering pavement types and materials are listed below:

- Traffic Loading type
- Material availability
- Material Cost
- Maintenance Requirements throughout the pavement lifecycle
- Material Embodied Carbon
- Possibility for material re-use at asset end of life

NPDP Step 5 - Material Characterisation

Materials are divided into two categories:

- Design Level 1 (DL1) includes a catalogue of pre-exiting pavement material mixtures
- Design Level 2 (DL2) allows for an improved consideration of the long-term performance characteristics of a material based on a laboratory evaluation of the material.

Performance Requirements of DL2

Performance requirements vary based on the following types:

- Bituminous Bound Materials
- Hydraulically Bound Granular Materials
- Low Energy Bound Materials
- Unbound Granular Materials

Table 2.4 New Pavement Material Performance Characteristics

Pavement Material	Performance Characteristic
Bituminous	• Stiffness • Resistance to Fatigue (Cracking),
Unbound Granular	• Stiffness
Hydraulically Bound Granular	• Stiffness • Resistance to Fatigue (Cracking)
Low Energy Bound Material	• Stiffness • Resistance to Fatigue (Cracking)

B1.1 Bituminous Bound Materials

Table B1 Bituminous Bound Material Works Performance Testing for Design Level 2

C	Test Method[1]	Performance	Performance Category
Stiffness[1]	Indirect Tensile Stiffness Modulus (MPa) EN 12697-26:2018 Annex C IT-CY 20ºC	≥1800	S1
		≥2500	S2
		≥4500	S3
		≥6500	S4
Resistance to Fatigue	ε_6 (failure strain level at $1x10^6$ load repetitions) EN 12697-24:2018 Annex E, IT-CY at 20ºC	<130	F1
		≥130	F2
		≥190	F3

Notes:

1. The above limits relate to the minimum of the average of the results from a set of test specimens.

2. Works testing frequencies to be agreed with TII Network Management on a project specific basis.

Pavement Strengthening Design Process (PSDP) – Part 1

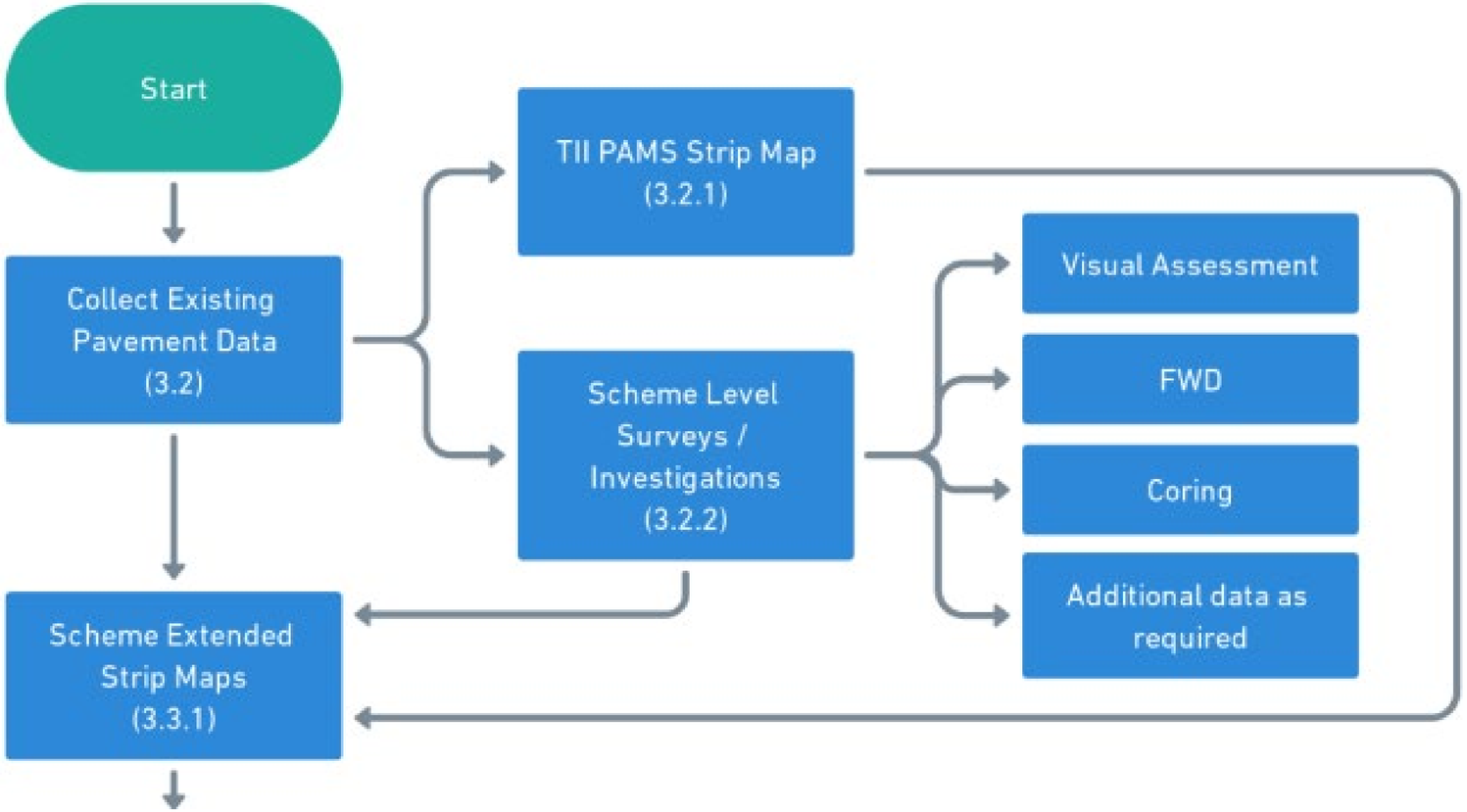


Figure 3.1 Existing Pavement Assessment and Maintenance Intervention Design Process

Pavement Strengthening Design Process (PSDP) – Part 2

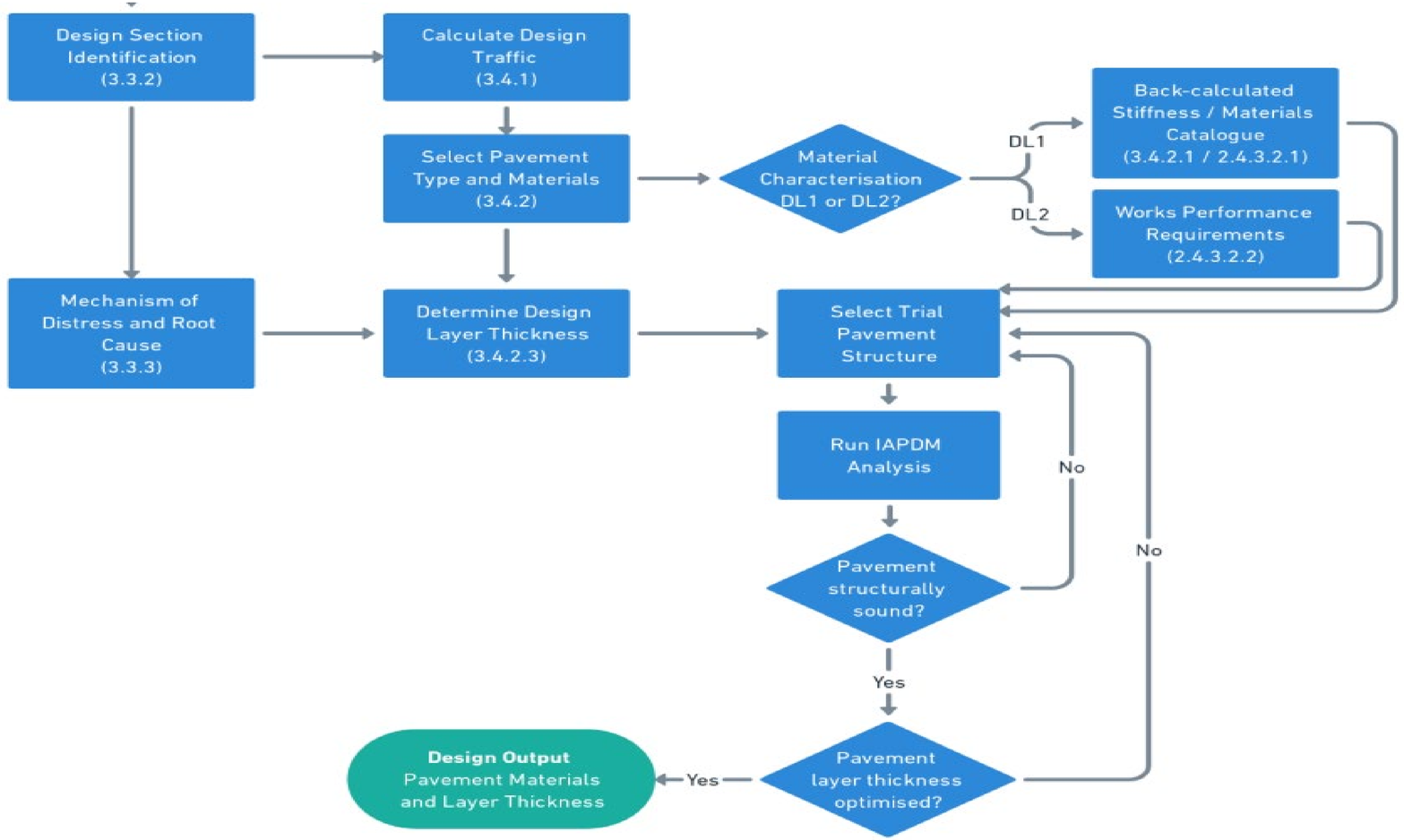


Figure 3.1 **Existing Pavement Assessment and Maintenance Intervention Design Process**

PSDP step 1 – Collect Existing Pavement Data

Information from the Pavement Asset Management System (PAMS) and scheme level surveys are to be used in the assessment of the existing pavement capacity.

PAMS Data:

- Road Surface Profilometer
- Laser Crack Measurement System
- Ground Penetrating Radar
- As built records

Scheme level surveys:

- Visual Inspection
- Falling Weight Deflectometer (FWD)
- Coring

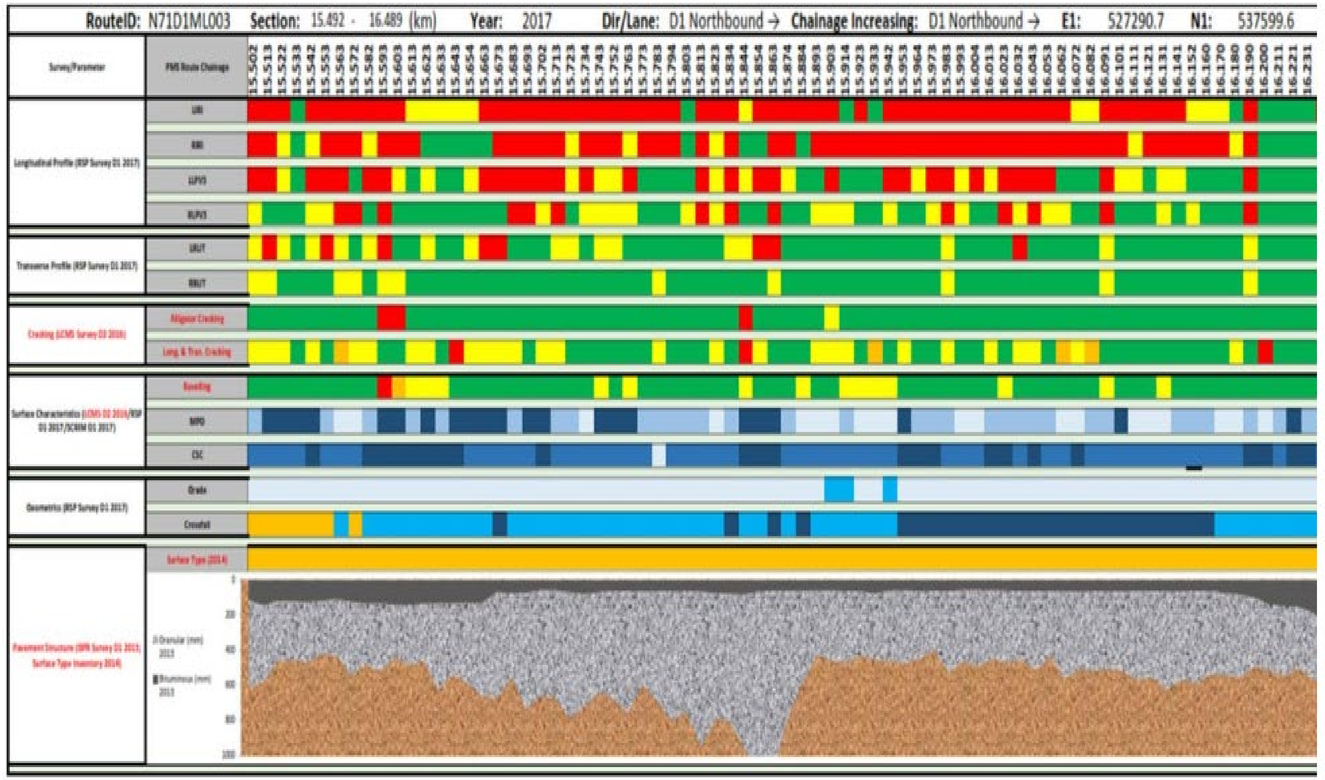
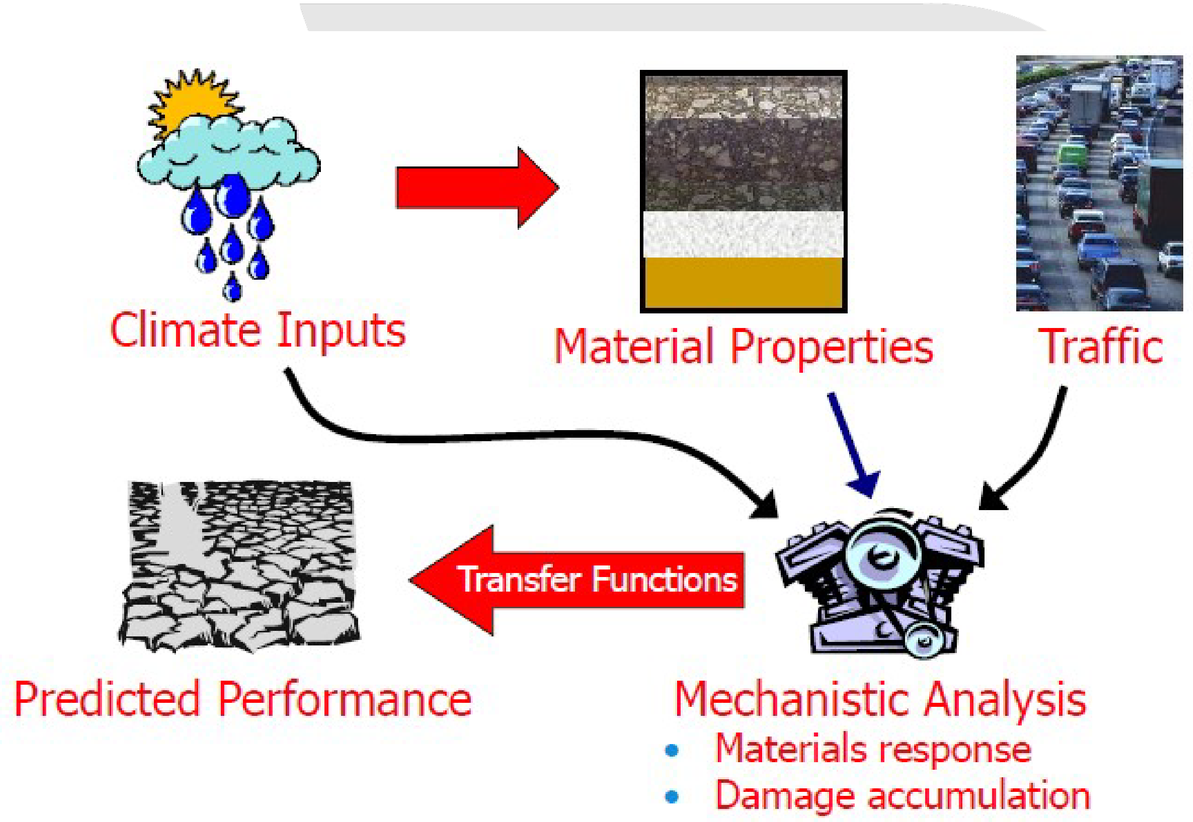


Figure 3.1 Typical PAMS Data in Strip Map Format

Development of the IAPDM

- Mechanistic-Empirical Pavement Design
- United States, Netherlands, France, Austria
- Material performance characteristics
- Irish environmental and loading conditions
- Long term performance e.g. cracking, deformation



Development of the IAPDM

- Model calibration through laboratory investigations

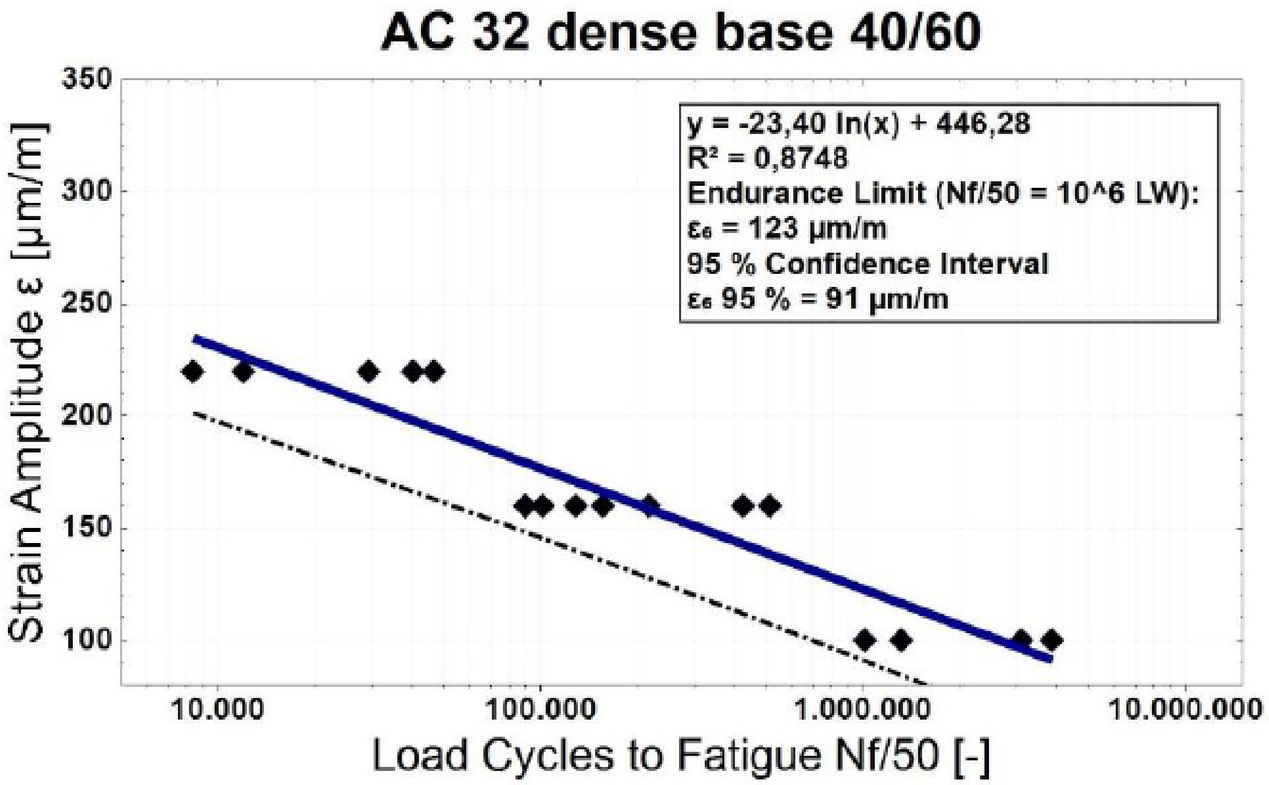
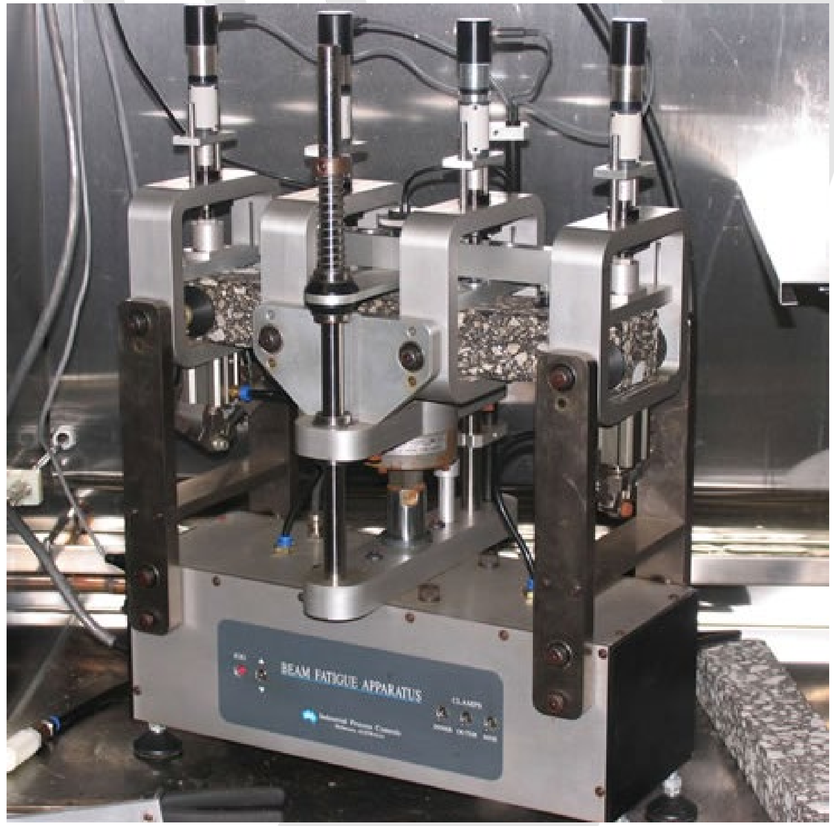


Figure 11: Fatigue results of AC 32 dense base 40/60



IAPDM Overview

1. Mechanistic - Empirical pavement design method developed for Irish conditions.

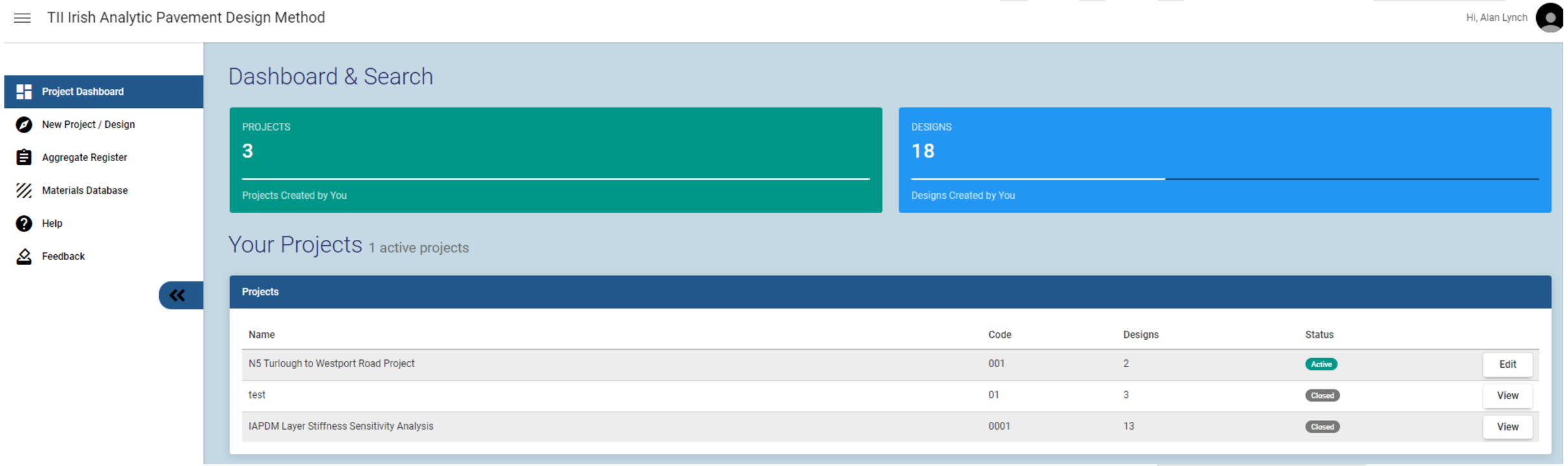
2. Customise a pavement structure based on the locality of Conditions and Materials

3. Pavement Responses due to traffic loading are calculated using a Multi - Layer Linear Elastic model (Mechanistic Part)

4. These responses are transferred to structural capacity through empirical models (Empirical part)

IAPDM on line tool – Part 1

- Design models within web-based software. To request access to the IAPDM please send your email address and mobile phone number to iapdm@tii.ie.



IAPDM on line tool – Part 2

Analysis Output

Layer No	Layer Type	Material	Thickness (mm)	Design Stiffness (MPa)	Poisson's Ratio	Critical Response Type	Critical Response Value	Structural Capacity (msa)	N/Nf	
1	Surface	SMA	40	2000	0.35	No tension	0	0.0	0.00	Success
2	Binder	AC20 40/60	60	4700	0.35	No tension	0	0.0	0.00	Success
3	Base 1	AC32 40/60	185	4700	0.35	epsilon r (Microns)	-80	21.4	0.93	Success
4	Unspecified	Not Considered	0	0	0.00	None	0	0.0	0.00	No Layer
5	Subbase	UGM A (CC-SPW-00800)	150	200	0.35	N/a	-	-	-	No Model
6	Capping	6F2 (CC-SPW-00600)	250	100	0.35	N/a	-	-	-	No Model
7	Subgrade	Subgrade	Semi-infinite	77	0.45	epsilon z (Microns)	1020	2898.6	0.35	SUCCESS / SUCCESS / SUCCESS

FC = II

Surface Modulus = 122

Implications of DN-PAV-03021