CEDR Transnational Road Research Programme Call 2013

Five programmes

- Ageing Infrastructure Management
- Traffic Management
- Safety
- Energy Efficiency
- Roads and Wildlife

Consortium CONSISTEND

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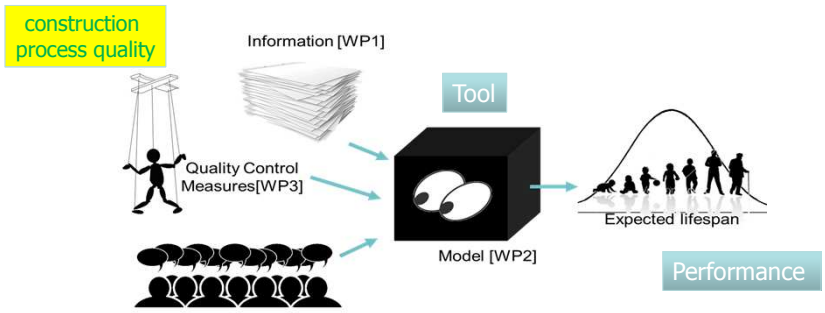
Overview CONSISTEND

- **Call:**
  - Feasible, valid and cost effective measures to reduce use of energy during construction and operation
- **Aim:**
  - A tool to assess the impact of construction process quality on the performance of pavements and its implementation in tenders in order to extend performance life of pavements
- **Steps:**
  - Collect information that relates construction quality to service life, based on data and expert opinions.
  - Collect information about currently practiced and innovative quality control methods, managing strategies and enforcement.
  - Build a risk-based tool that presents the most important parameters that influence service life.
  - Explore the possible roles for the tool in a procurement procedure in consultation with National Road Authorities and road industry.

Objective of CONSISTEND

Development of a tool to assess the impact of
construction process quality
on the performance of pavements and its implementation in tenders

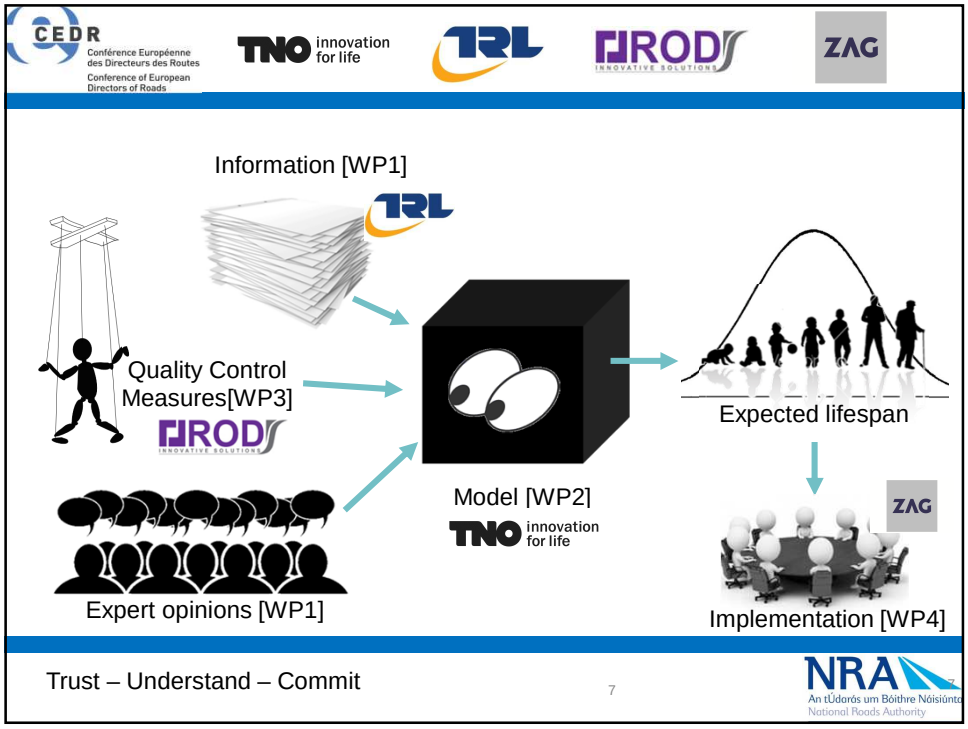


Example MEAT
Most Economically Advantageous Tender

Contractor A: Normal good Quality
Contractor B: Extra Quality

	Contractor A	Contractor B
Offer	1.000.000	1.050.000
Added value	0	100.000
Offer – added value	1.000.000	950.000

For this calculation we need a tool to estimate added value


Information [WP1]
Quality Control Measures[WP3]
Expert opinions [WP1]
Model [WP2]
Expected lifespan
Implementation [WP4]
Trust – Understand – Commit
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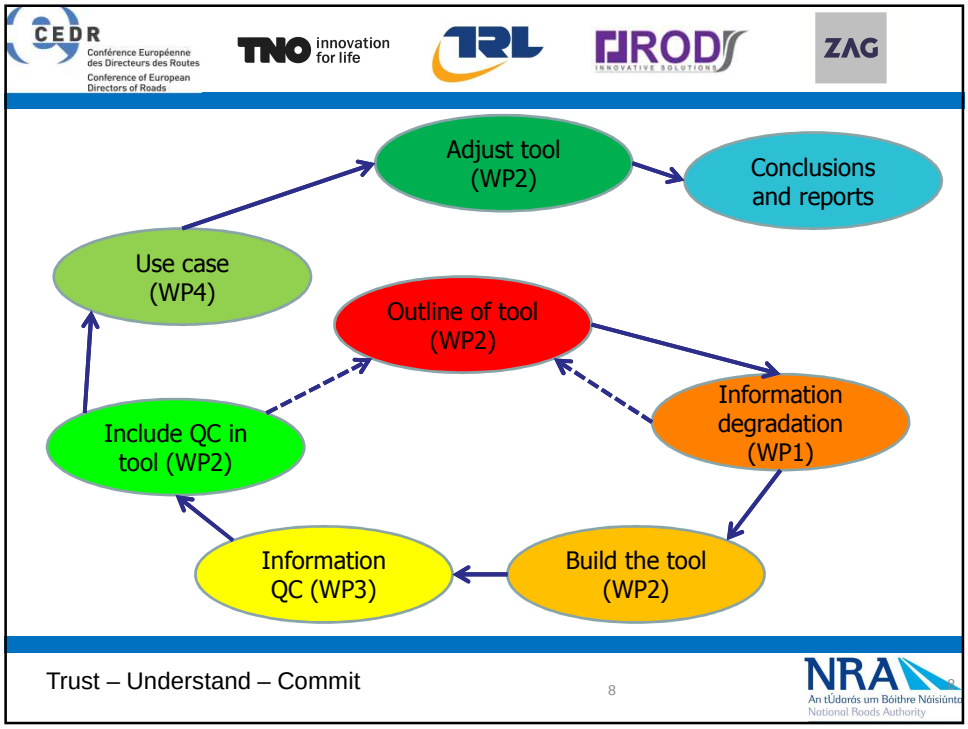
Adjust tool (WP2)
Conclusions and reports
Use case (WP4)
Outline of tool (WP2)
Information degradation (WP1)
Include QC in tool (WP2)
Information QC (WP3)
Build the tool (WP2)
Trust – Understand – Commit
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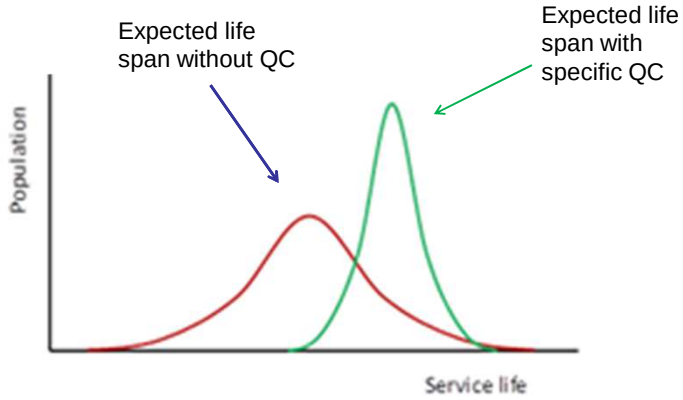
CONSISTEND model

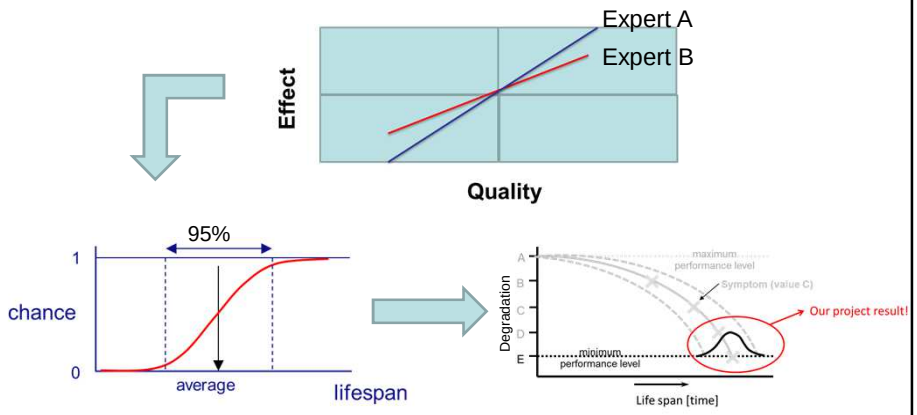


WP2: Construction of a quality assessment tool

TNO

Trust – Understand – Commit

Principle of the tool



Information in model

Input Project

Based on project specific circumstances:
- Actual value of degradation factor i

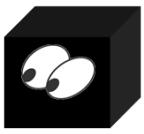
Model

Introduced by model:
- Variety in lifespan that can not be explained from degradation factors

$$L = A + B + C$$

Expert opinions

Based on results questionnaire:
- Expected lifespan in years
- Change in lifespan
- Default value for degradation factor i
- Maximum lifespan in years



WP1: Identification and evaluation of pavement construction process influencing parameters

TRL

Trust – Understand – Commit

Literature review – objectives

- Understand the key material properties that determine performance and durability;
- Available information on the impact of construction practices on the achievement of these properties;
- And the extreme values between which the key material parameters can vary.

Gather information on:
Transport
Laying
Compaction
One material per country

Functions influenced

Questionnaire focussed on most commonly used surface course mixtures across the four countries

Country	Material(s)
England	BS EN 13108-4: HRA 35/14 F Surf 40/60
Ireland	
The Netherlands	NEN-EN 13108-7 ZOAB 16+ Porous Asphalt
Slovenia	AC 11Surf B50/70 for main roads and SMA8 PmB 45/80-65 for motorways

Comments

Trust – Understand – Commit

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Functions influenced

Degradation factors

Transport, Laying, Compaction

High, Medium, Low

Comments

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Questionnaire in more detail

C20 | Optimum | (Ideal value for this property)

	A	B	C	D	E	F	G
5	**Section 1: Please complete dark grey cells**						
6	**Name**		Joe Bloggs		**Comments**		
7	**Country**		UK				
8	**Surface Course Type (Based on EN 13108)**		Part 5 (10mm SMA)				
9	**Expected Lifespan of the material (years)**		12				
10	**Maximum lifespan of chosen material (years)**		20		Maximum lifespan you would expect to see.		
11	**Minimum lifespan of chosen material (years)**		6		Minimum lifespan you would expect to see.		
12	**Area of expertise/Job Function**		Consultant		(e.g. Consultant, materials supplier, contractor, equipment provider)		
13							
14	**Section 2:**						
15	*a. Please complete columns C to G in the dark grey cells. Please insert a single value in each cell rather than a range.*						
16	*b. Please use the comments section if want to include addtional explanation of an answer.*						
17	*b. If you feel you are not confident about answering a certain question, you can make a note in the comments section and leave the answer cell blank.*						
18	*c. The questionnaire aims to gather knowledge of personal experience. Please do not refer to literature for answers.*						
19						*Change in lifespan: extension (+) or reduction (-)*	
20	**Factor**	**Phase,** *T = Transport, L = Laying, C = Compaction*	**Optimum** *(Ideal value for this property)*	**Minimum** *(Lowest value you would ever expect to see)*	**Maximum** *(Greatest value you would ever expect to see)*	**Change in Lifespan for minimum (years)**	**Change in Lifespan for maximum (years)**
21							
22	*Temperature of material*	T	160	140	185	-1	-4
23		L	140	120	160	-3	-2
24		C	125	90	140	-4	2

INTRODUCTION / QUESTIONNAIRE / Example

Ready

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Industry analysis

- Questionnaire was sent around
- Resulted in 25 received questionnaires in total
- Results to undergo statistical analysis

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Temperature of material
Weather
….Ambient Temperature (° C)
….Wind Speed (km/h)
….Ambient Temperature (° C)
….Rainfall
….Wind Speed (km/h)
….Ambient Temperature (° C)
….Rainfall
Compaction
….Void Content (%)
….Number of roller passes

Equipment
Workmanship
Travel time and delays (with an insulated truck)
….Haulage time from the plant (minutes)
….Queue to offload (time delay incurred on site)
….Waiting at paver for next load (minutes)
Joints (longitudal joints)
….Construction
….Number of joints
Interlayer bond
….Amount (g/m2)*

Expected Lifespan of the material (years)
Maximum lifespan of chosen material (years)
Minimum lifespan of chosen material (years)

Trust – Understand – Commit

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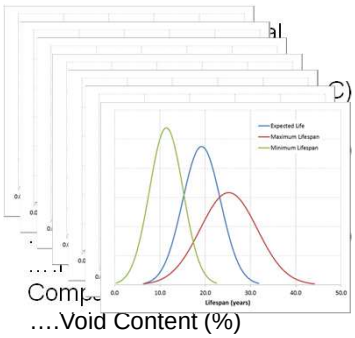

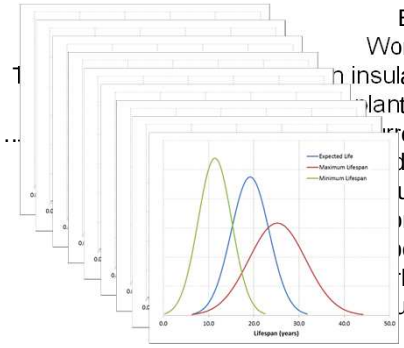

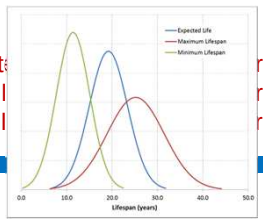

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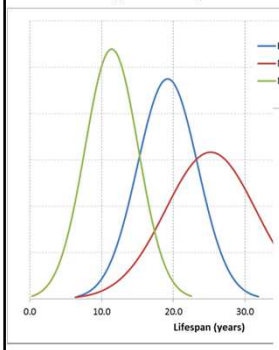
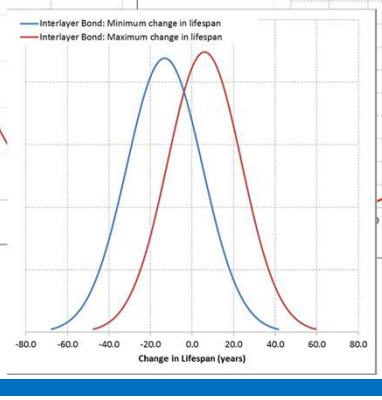
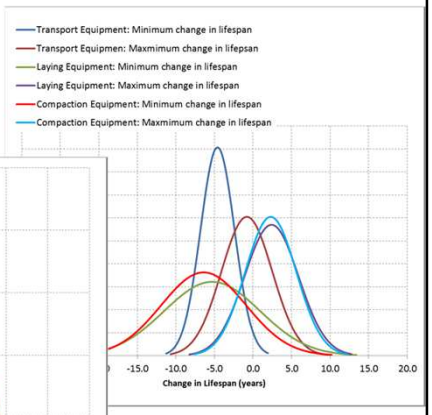
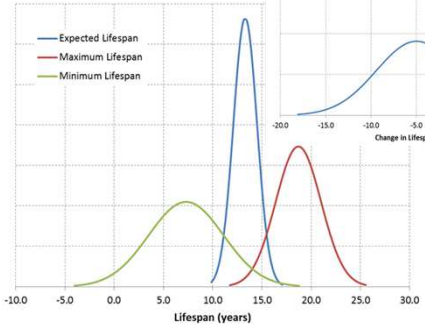
Industry analysis – England & Ireland

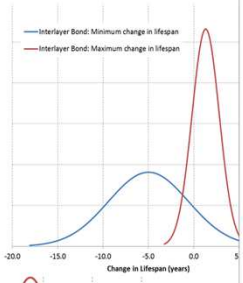


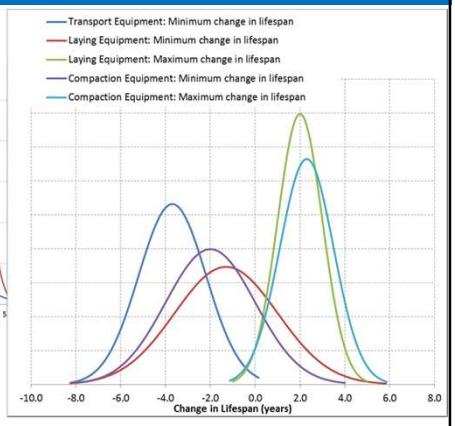




Industry analysis – The Netherlands







WP3: Integration of Tool With Currently Practiced Quality Control Methods

ROD-IS

Trust – Understand – Commit

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Objectives

- To collect information about available quality control methods, and their characteristics.
- To obtain information about practical aspects when applying quality management strategies and enforcement by contractors and road owners.
- Information to be implemented in tool.

Inventory

- An inventory of quality control methods has been compiled
- Categorised based on their application to:
  - Transport
  - Laying
  - Compaction
- Their effect on the critical construction parameters is of interest

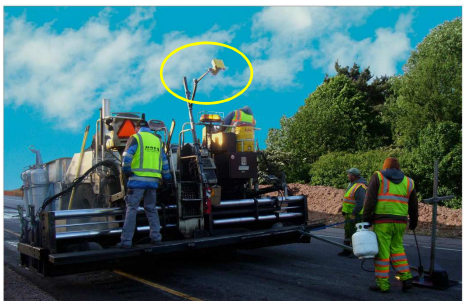
Transport

- Insulated Trucks – Standard Practice
- Asphalt Logistics Information System (ALIS)
  - Helps ensure a constant supply
  - Live tracking of trucks (GPS)
  - Information on capacity of mill
  - On Iphone/Tablet

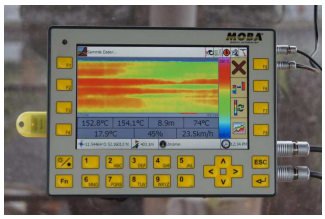
Laying

- Infrared monitoring of temperature
  - Temperature behind paver
  - Identify temperature issues
  - Displayed on paver
  - Linked to GPS coordinates

Infrared scanner linked to GPS



Infrared temperature scanner



Live display on paver

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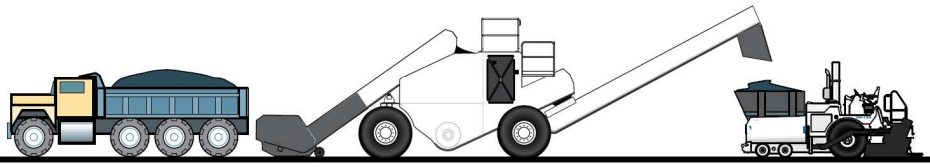
Laying

- Shuttle Buggy
  - Remixes material between truck and paver
  - Benefits:
    - Even of distribution of temperature and aggregate
    - No bumping of paver
    - Storage (up to 23 t) of material for constant supply
    - Supply multiple pavers



Laying

- Echelon Paving
  - Construction of hot joints for improved quality

Compaction

- Intelligent Compaction
  - Infrared sensors for temperature
  - GPS for number of passes

GPS

Infrared sensor

In-cab display

Transport, Laying & Compaction

- Workmanship – Appropriate training & supervision

- Weather station
  - Wind
  - Ambient temperature
  - Rain

QC on temperature during laying

Normal QC

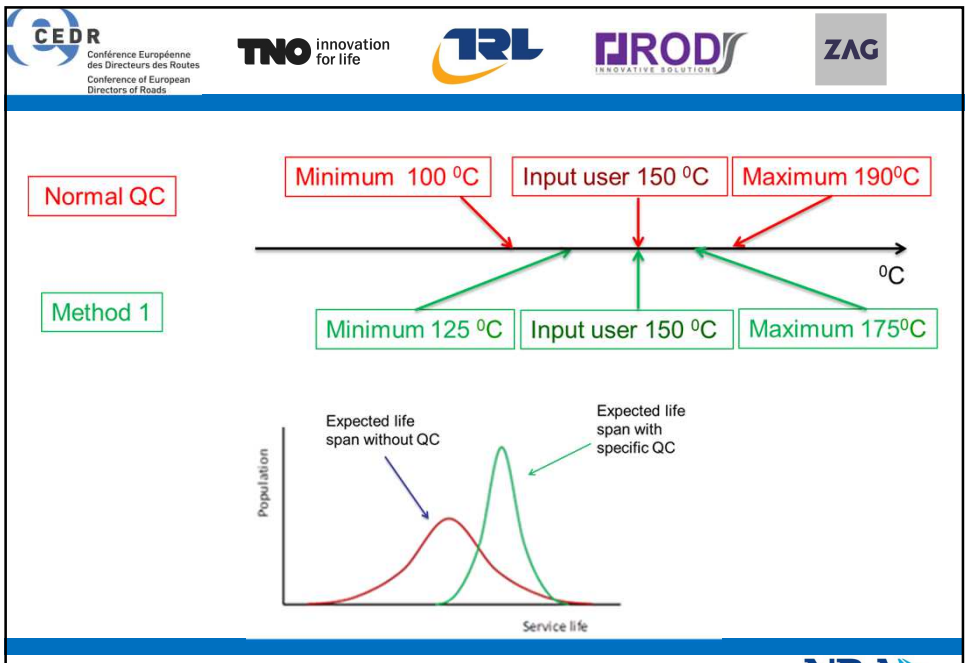
Minimum 100 ^{0}C | Input user 150 ^{0}C | Maximum 190^{0}C

^{0}C

Method 1

Minimum 125 ^{0}C | Input user 150 ^{0}C | Maximum 175^{0}C

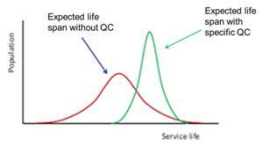
	Temperature during laying	Bandwidth
Method0	No method	*Questionnaire results suggest that the temperature ranges from 100 - 190 for HRA. Bijleveld (2015) mesured temperature drops of up to 100C when paver was forced to stop.*
Method1	ALIS - Asphalt Logistics Information System	*Optimum temperature +/- 25C*
Method2	Paver IR&GPS	*No direct effect*
Method3	Shuttle buggy	*For a single field study by Bijleveld a Shuttle Buggy/MTV reduces the standard deviation of the temperature behind the screed from 15C to 5C.However, it reduces the overall temperature of the mix by 5-20C.*
Method4	Handheld IR	*No direct effect*



WP4: Implementation of tool in practice

ZAG

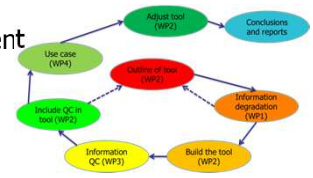
Use cases



- Evaluate:
  - Tool results normal QC
  - Tool results extended QC
  - Tool results before and after
  - Asphalt quality after construction versus tool results
- Analyse use for tender evaluation
- Discuss extention of model for other asphalt types, etc.

Tool results

- 3 versions of tool tuned
  - Expert opinions are material and circumstance bound
- Tool adjusted due to use in pilot projects:
  - Two options in the tool: "during contract phase" and "after construction phase"
  - Tuning of the tool adjusted
  - Recommendations for further development



Tool results, case Slovenia

Contract phase	After const. ph. 1	After const. ph. 2
• 15,8 year	• 15,4 years	• 14,1 years
• Optimal conditions • No uncertainty (where possible)	• Same (optimal) conditions and uncertainty	• Relatively large uncertainties • Double transport time • Higher ambient temperature

Tool results

- Results as expected:
  - Optimum circumstances => maximum life span
  - Changes in circumstances (not optimal) or larger uncertainty => life span decreases
- Results remarkable:
  - Large uncertainty in life span (according to experts)
- Results less distinguishing than anticipated:
  - Changes in expected life span due to non-optimal input and (especially) larger uncertainty do not lead to expected large changes in life span.

Tool in procurement

- MEAT options:
  - Objective calculation of life span
  - Quantified values
  - Check after construction (objectively quantified)
  - Bonus – malus option to settle final payment

Example MEAT
Most Economically Advantageous Tender

Contractor A: Normal good Quality
Contractor B: Extra Quality

	Contractor A	Contractor B
Offer	1.000.000	1.050.000
Added value	0	100.000
Offer – added value	1.000.000	950.000

A CONSISTEND(T) assessment of the "added value"!

Future development

- Less degradation factors =>
  larger influence of each factor
- Interdependency degradation factors =>
  model / input should deal with this
- Country and material extension =>
  specific tuned versions of the model

17/08/2016

Dissemination CONSISTEND

- Interaction with NRA's through case studies and workshops
- Interaction with other projects, e.g. SHARP 2 and ASPARI.
- End report, final power point presentation and tool.
- Paper at IALCCE 2016
- Website
- Conferences (FIRM, national opportunities)

CONSISTEND Summarized

- Assessment of service life of asphalt based on expert opinions
- To be specifically tuned (circumstances, country, type of asphalt)
- Depending on values of degradation factors
- Including QC measures
- Tuned for 3 countries and 4 types of asphalt
- Useful in procurement
- Large uncertainty in life span (according to experts)
- Well disseminated in workshop and presentations
- Positive response to concept
- Non-optimal input and (especially) larger uncertainty do not lead to the expected changes in life span
- Improvement recommended to trust outcome

Thank you for your attention

Questions!?

CONSISTEND Website: http://consistend-cedr.zag.si/en/index.php?nav1=home