# Economic impact of including pavement structural condition into pavement management decisions

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# Introduction

Pavement Condition

- **Surface Condition** → **Condition Index**
  - Cracking
  - Patching
  - Rutting
  - Bleeding
  - Potholes...
- **Structural Condition**
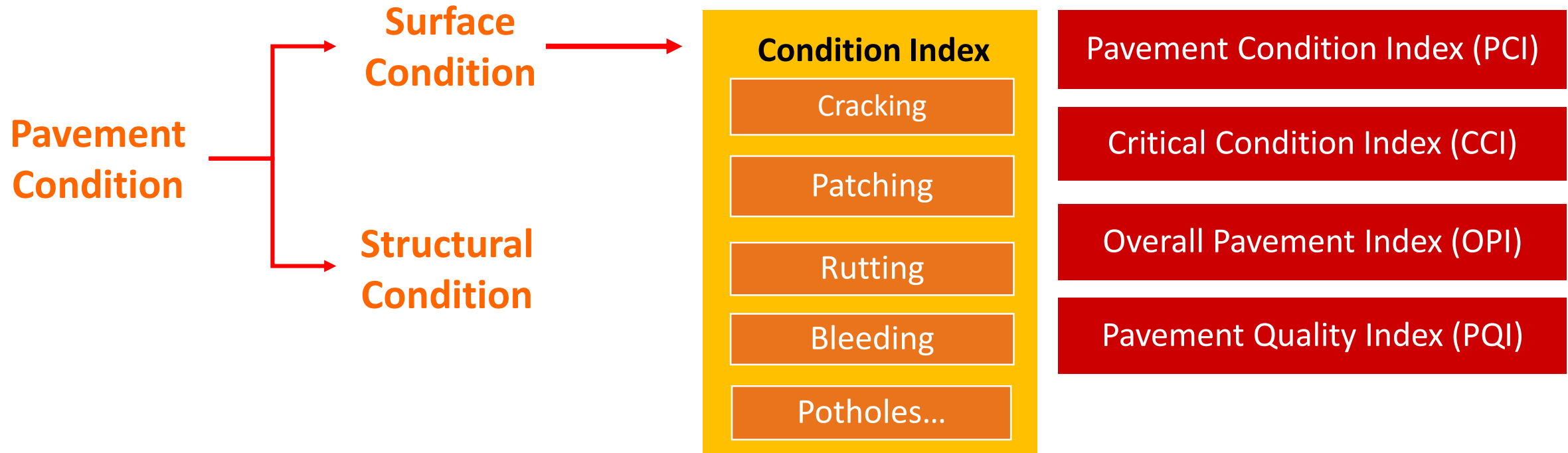
- Pavement Condition Index (PCI)
- Critical Condition Index (CCI)
- Overall Pavement Index (OPI)
- Pavement Quality Index (PQI)

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# Introduction

- VDOT decision making process

**Distress Based** → **CCI Filter** → **Structural Condition Filter**
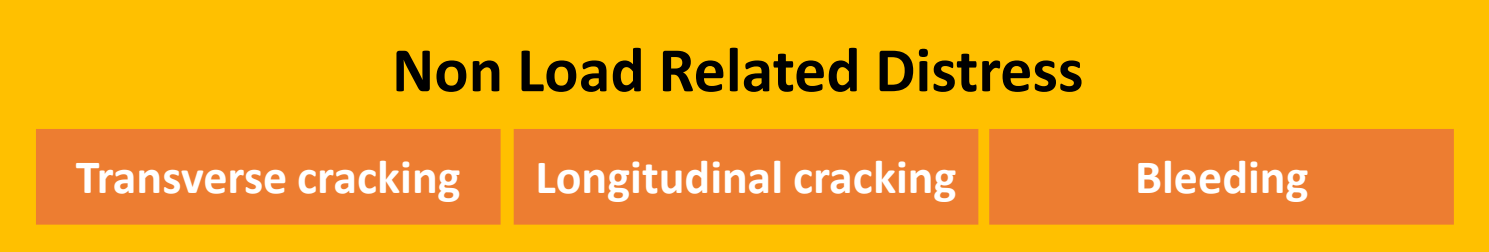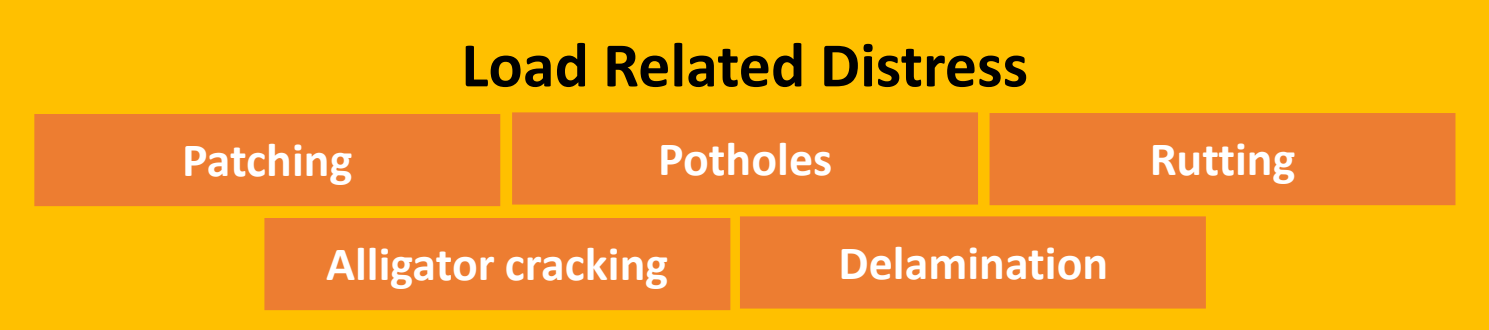
Distress Based:
- Alligator Cracking
- Transverse Cracking
- Rutting
- Potholes

|  |  | | Alligator Cracking | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency | | | R | | | O | | | F | | |
| | | Severity | NS | S | VS | NS | S | VS | NS | S | VS |
| Transverse Cracking/Mile | 0 – 50 | NS | DN | DN | PM | DN | PM | CM | PM | CM | RM |
| | | S | DN | DN | CM | DN | PM | CM | PM | CM | RM |
| | | VS | CM | CM | CM | CM | CM | CM | CM | RM | RM |
| | 51 - 74 | NS | DN | DN | PM | DN | PM | CM | PM | CM | RM |
| | | S | DN | DN | CM | DN | PM | CM | PM | CM | RM |
| | | VS | RM | RM | RM | RM | RM | RM | RM | RM | RM |
| | 75 - 199 | NS | DN | DN | CM | DN | PM | CM | PM | CM | RM |
| | | S | CM | CM | CM | CM | CM | CM | CM | CM | RM |
| | | VS | RC | RC | RC | RC | RC | RC | RC | RC | RC |
| | ≥200 | NS | PM | PM | CM | PM | PM | CM | PM | CM | RM |
| | | S | CM | CM | CM | CM | CM | CM | CM | CM | RM |
| | | VS | RC | RC | RC | RC | RC | RC | RC | RC | RC |

Note: For Transverse Cracking, VS applies to composite pavement only.

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# Introduction

- VDOT decision making process



| Distress Based | → | CCI Filter | → | Structural Condition Filter |

| Treatments | Interstate | Primary |
|---|---|---|
| DN | >89 | >89 |
| DN, PM | >84 | >79 |
| CM, RM, RC | <60 | <60 |
| RM, RC | <49 | <41 |
| RC | <37 | <26 |

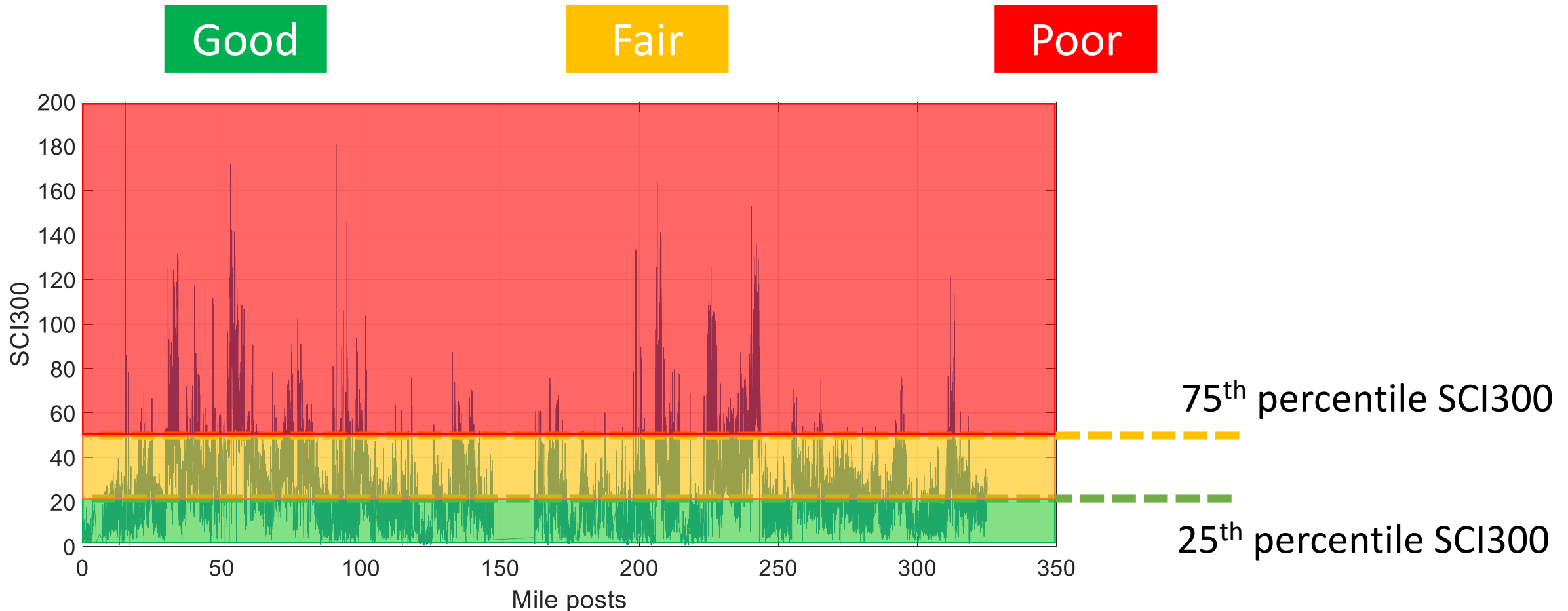# Introduction

- VDOT decision making process
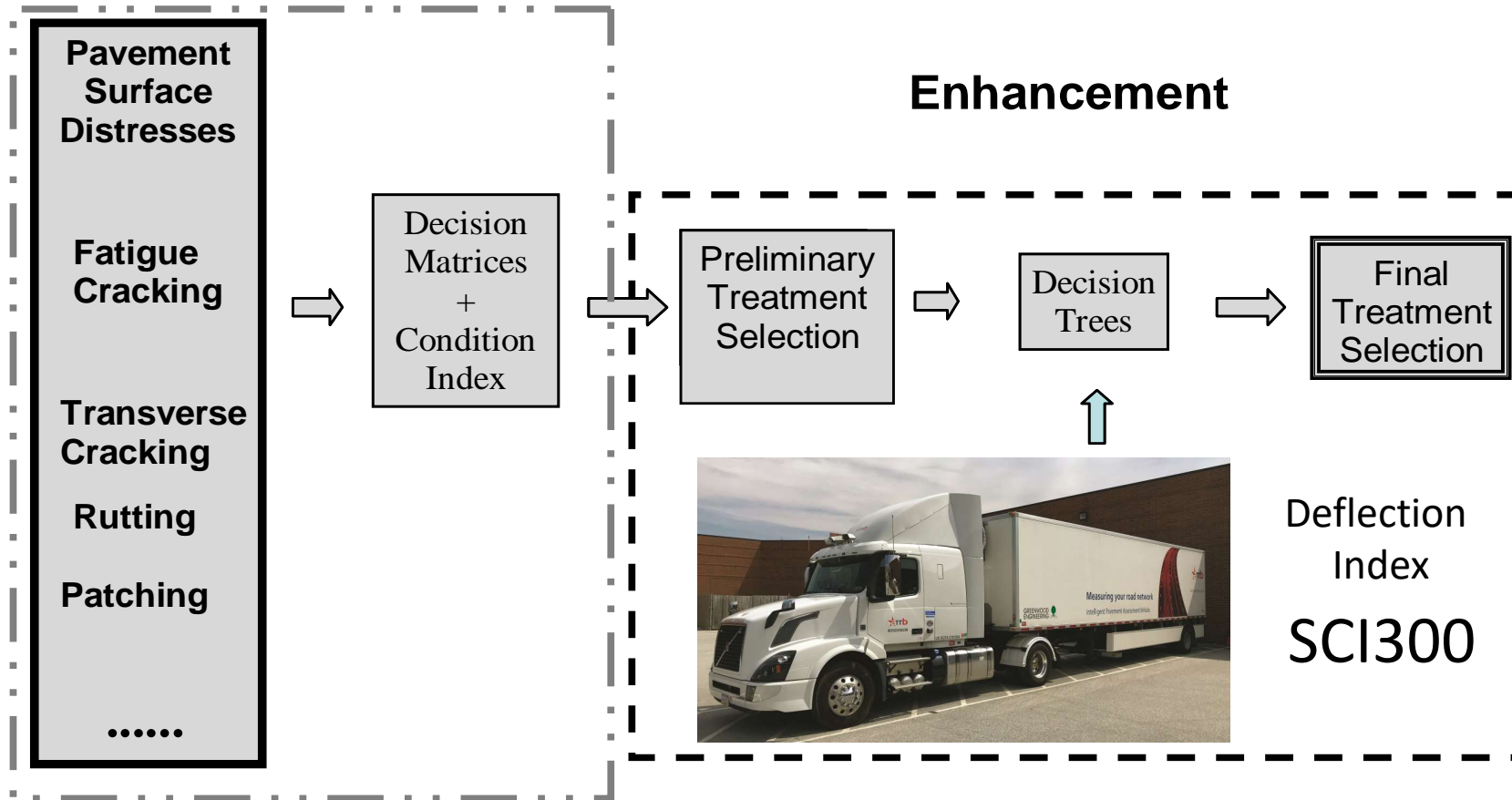
# Objective

- Evaluate the economic impact of incorporating the pavement structural condition into PMS treatment selection process

# Methodology

- Categorize the pavement into different structural condition

# Methodology

Treatment Selection tool combining pavement surface and structural condition

| Initial Treatment Category | Modified Treatment Category with Structural Condition Category | | |
|---|---|---|---|
| | Strong | Fair | Weak |
| DN | DN | DN | DN |
| PM | PM | PM | DN |
| CM | PM | CM | RM |
| RM | CM | RM | RC |
| RC | RM | RC | RC |

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# Methodology

• Cost of the treatment

| District | PM | CM | RM | RC | |
|---|---|---|---|---|---|
| | | | | BOC/BOJ | BIT |
| Bristol | $24,714 | $86,726 | $165,743 | $450,890 | $465,747 |
| Salem | $24,714 | $115,494 | $193,780 | $494,910 | $495,617 |
| Lynchburg | N/A | N/A | N/A | N/A | N/A |
| Richmond | $24,714 | $79,227 | $145,265 | $414,871 | $451,481 |
| Hampton Roads | $24,714 | $95,262 | $171,201 | $469,997 | $470,704 |
| Fredericksburg | $24,714 | $92,877 | $181,464 | $497,156 | $513,359 |
| Culpeper | $24,714 | $85,295 | $165,337 | $432,163 | $425,801 |
| Staunton | $24,714 | $106,027 | $186,320 | $494,647 | $497,200 |
| NOVA | $25,257 | $93,484 | $171,488 | $469,053 | $471,661 |
| **Statewide** | **$24,714** | **$90,283** | **$171,544** | **$468,519** | **$479,785** |

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# Results

**_Unconstrained Analysis_**

Example: I81SB

3 scenarios:
a. Initial Treatment Category only
b. Initial Treatment Category + Strong & Fair Pavements
c. Initial Treatment Category + Strong, Fair and Poor Pavements

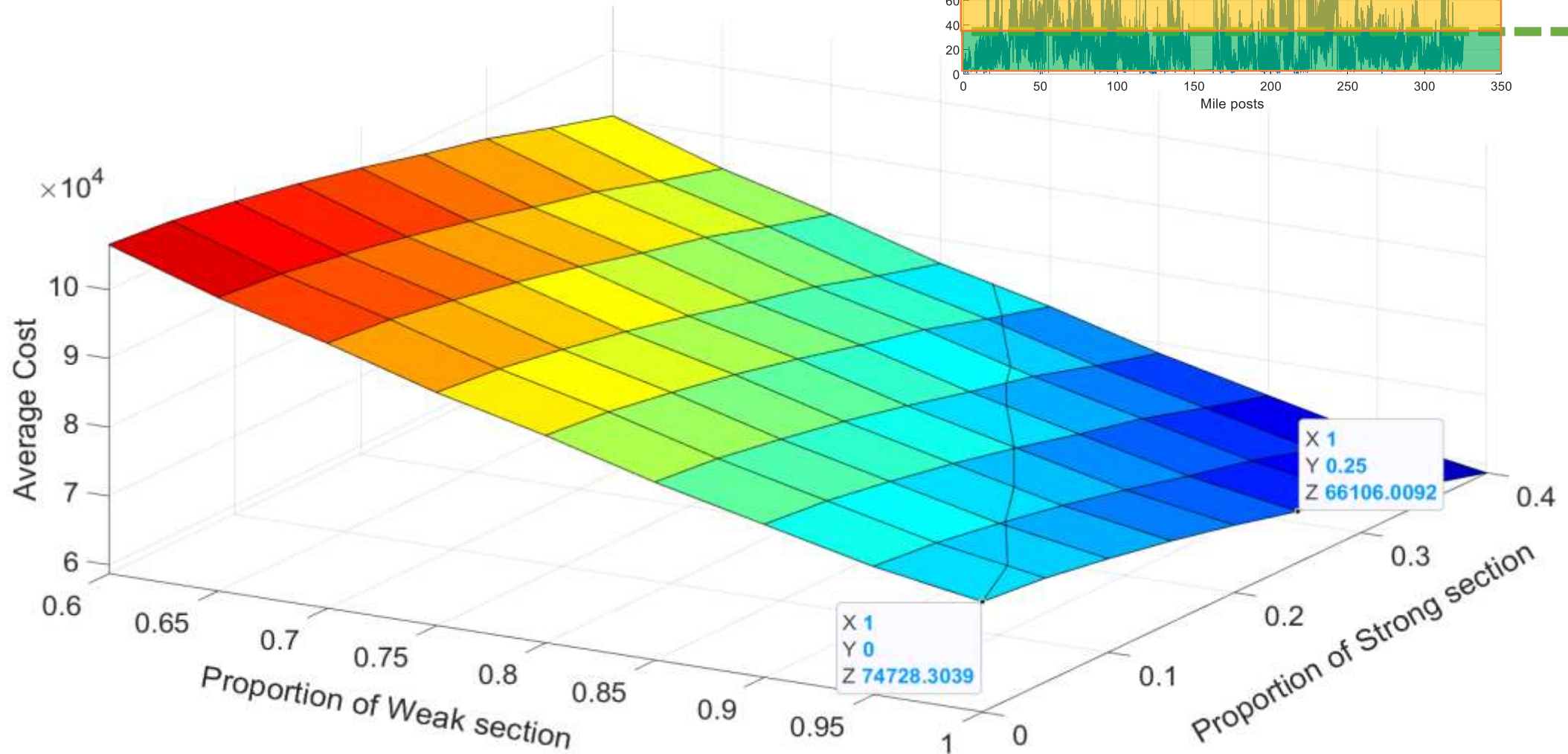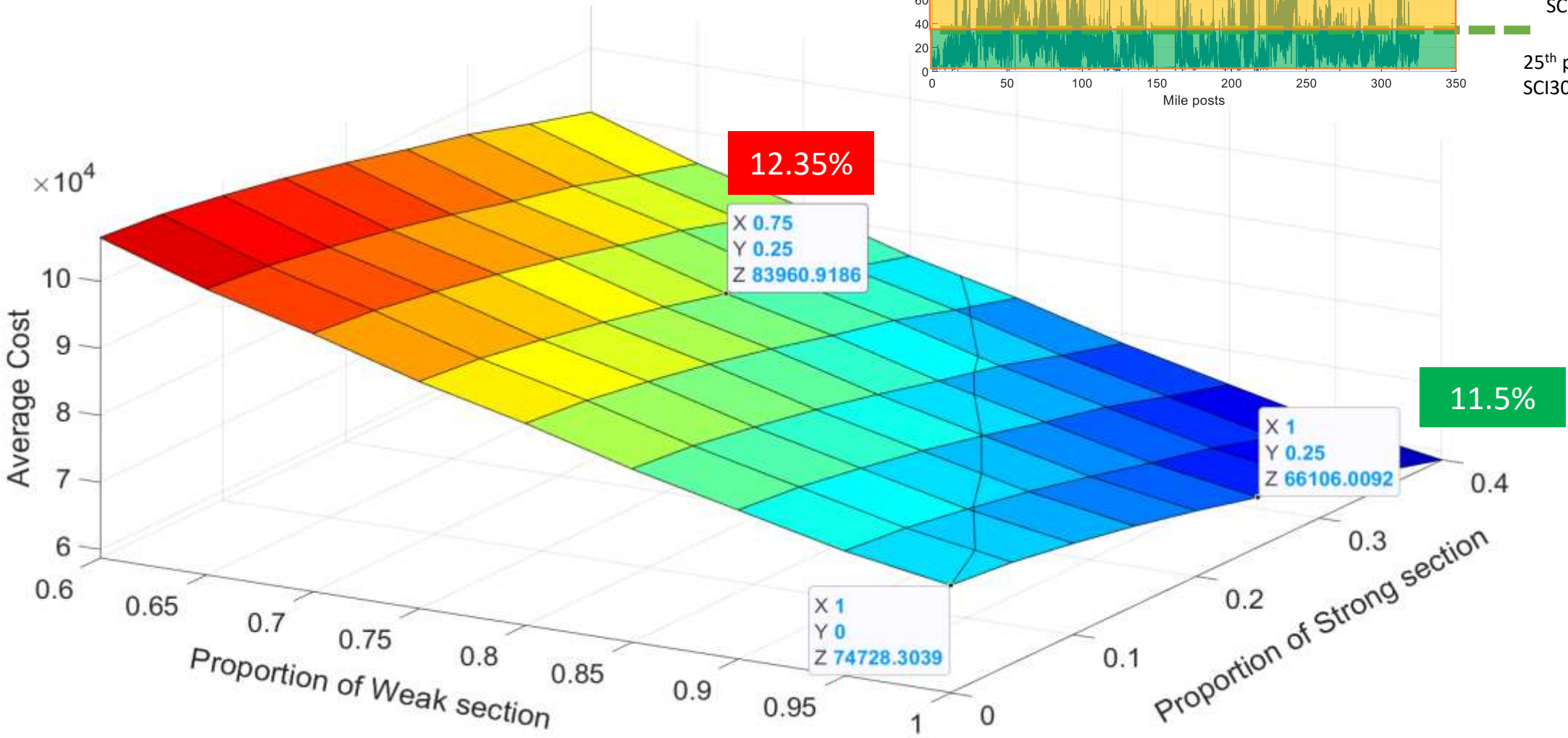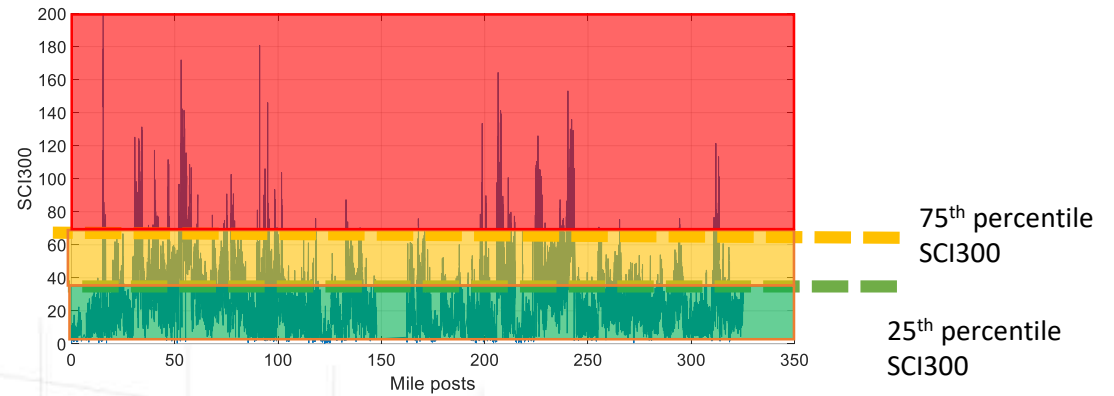| Initial Treatment Category | Modified Treatment Category with Structural Condition Category | | |
|---|---|---|---|
| | Strong | Fair | Weak |
| DN | DN | DN | DN |
| PM | PM | PM | DN |
| CM | PM | CM | RM |
| RM | CM | RM | RC |
| RC | RM | RC | RC |

# Results

## Scenario: A
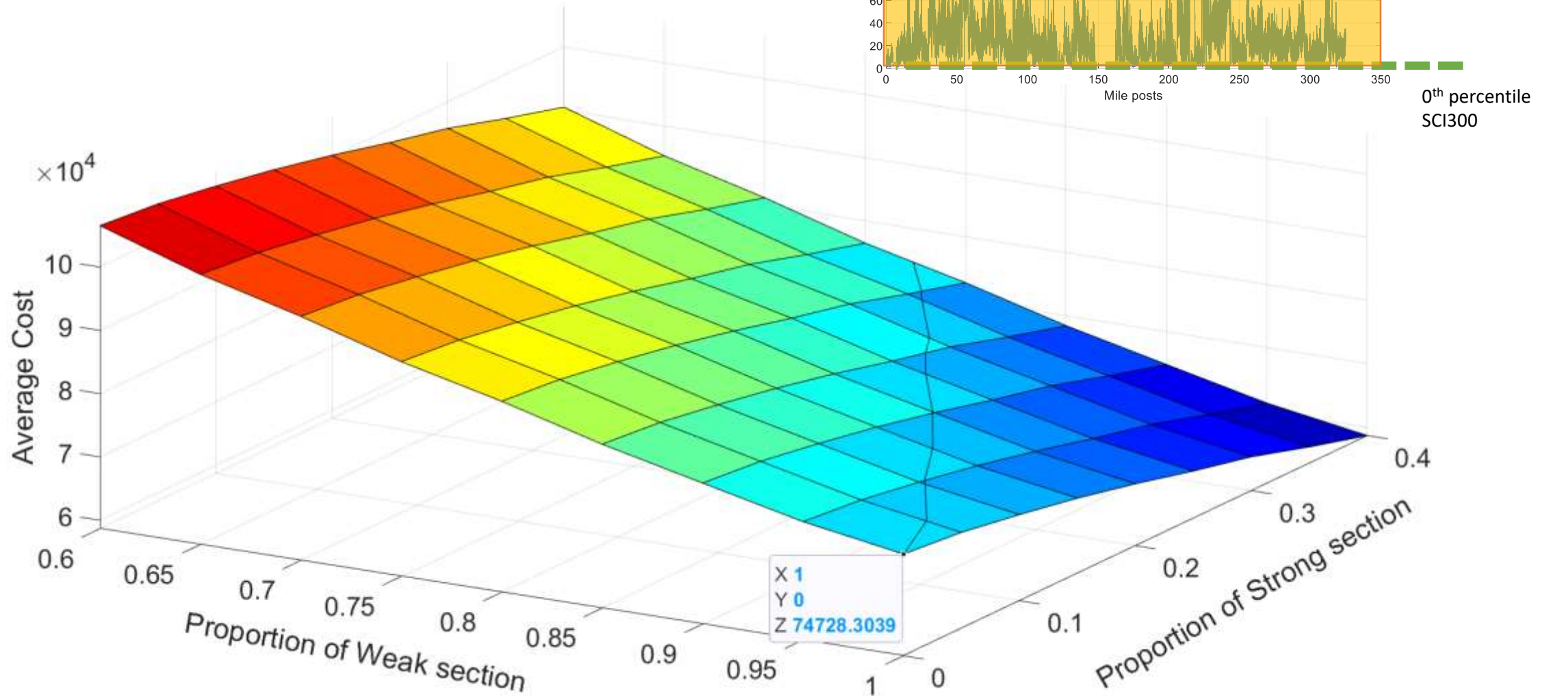
# Results
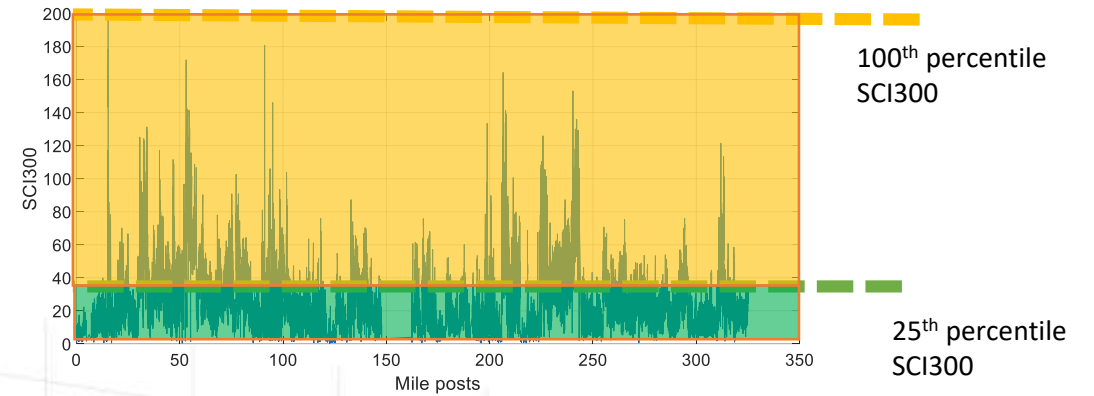
# Results

Scenario: C

# Results

Deterioration Model:

$$CCI = 100 - \exp\left(\beta_0 + \beta_1 \log(Age) + \beta_2 \log(Age) \times SCI300\right)$$

$$= 100 - \exp\left[\beta_0 + \beta_1\left(1 + \beta_3 SCI300\right)\log(Age)\right]$$

Rate of deterioration: $\beta_1\left(1 + \beta_3 SCI300\right)$

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# Results

## Unconstrained Analysis

Assumption:
- DN : No structural improvement
- PM : No structural improvement
- CM : 75$^{th}$ percentile SCI300
- RM : 25$^{th}$ percentile SCI300
- RC: 5$^{th}$ percentile SCI300

| Scenarios | Mean SCI300 | Rate of deterioration: |
|---|---|---|
| 1. Current condition | 24.80 | 1.09952 |
| 2. Initial Treatment Category only | 21.11 | 1.08274 |
| 3. Initial Treatment Category + Strong, Fair and Poor Pavement | 18.81 | 1.07227 |

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# Results
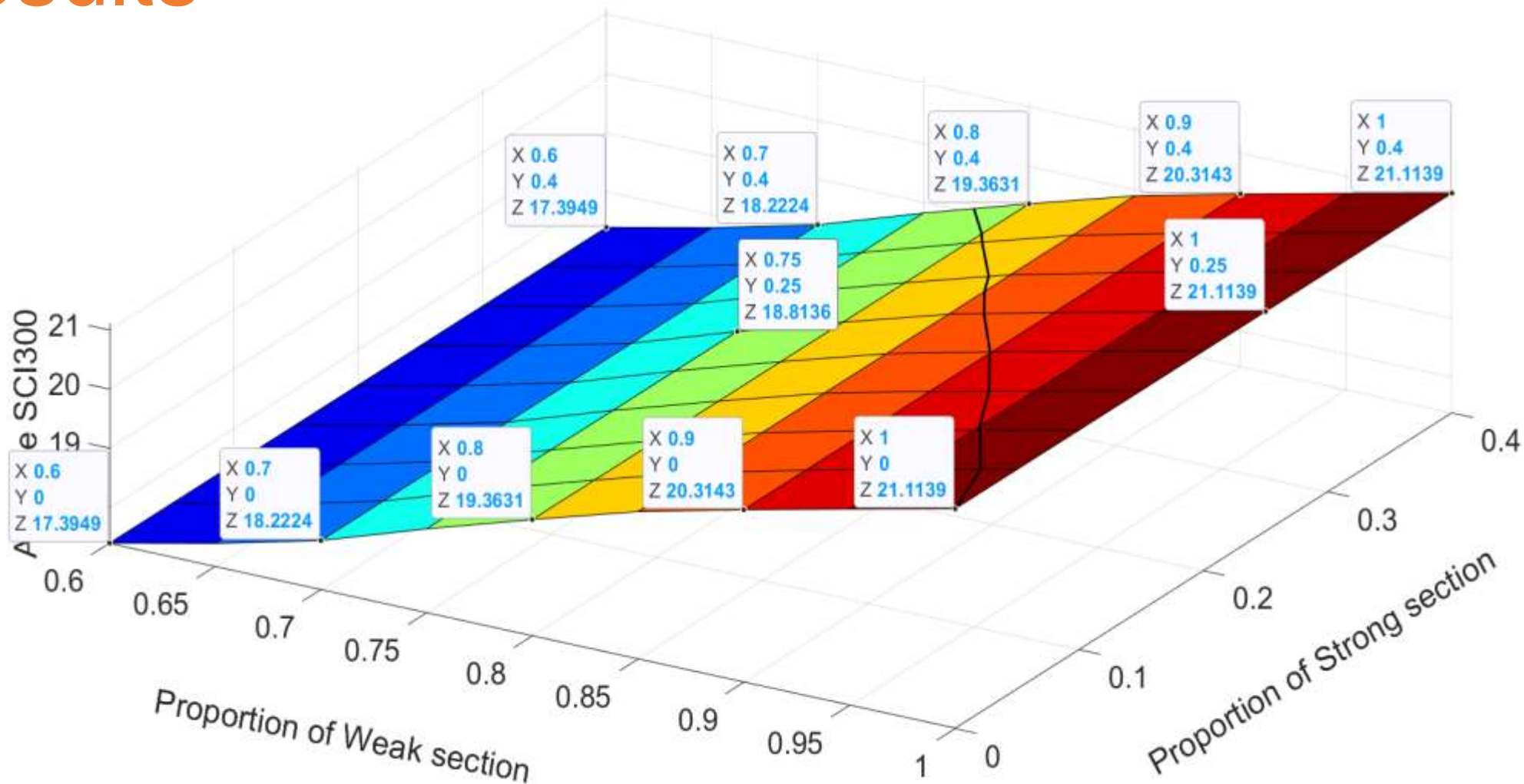
# Moving Forward

- Constrained Analysis : Limited Budget scenarios
- Longer time frames: 5-10 years

# Conclusion

1. Economic Impact of varying the structural condition threshold was evaluated.

2. Incorporating the pavement structural condition in the pavement treatment selection tool can be used for:

   • Identifying pavements that are structurally strong and opting for lighter treatments, which results to savings in short term.

   • Targeting pavement sections that are structurally weak and opting for heavier treatments. Despite the increase in cost would lead to improvement in pavement structural condition.

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# Thank you