The Unseen Impact of California Wildfires on Affected Roadway Pavements

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Overview

• Pavement Condition
• Pavement Damage Estimation
  – Visual - PCI
  – Structural - “Use of Life”
  – Examples
• Agency Expectations and What To Do
• Conclusions
Wildfires and Pavement Condition

Fire Traffic Duration

TIME

CONDITION

NORMAL TRAFFIC  MODERATE FIRE RELATED TRAFFIC  SEVERE FIRE RELATED TRAFFIC
Pavement Damage

- Environmental
  - Sun
  - Temperature
  - Water
  - Time
  - Fire

- Trucks
  - Fire & Related Vehicles
  - Debris/Recycling
  - Construction
  - ESAL – Equivalent Single Axle Load
Fire-Related Damage – Most Common

- Alligator Cracking / Fatigue Cracking
- Edge Cracking (non-improved/rural)
- Rutting – on low volume/thin section roads
- Accelerated aging – due to fire itself

- Not absolute and varies by location
Vehicle Loading on a Pavement

Wheel Load

- Hot Mix Asphalt
- Base
- Subbase
- Subgrade – Native soil
Alligator Cracking (Fatigue) Mechanism

Wheel load

HMA surface
Base
Subbase
Soil
Propagation of Fatigue Cracking

Distress is more severe at the bottom of the Asphalt Concrete
Fatigue
Alligator Cracking (Truck Loading)
Rutting
Rutting (Permanent Deformation)

Wheel load

- HMA Surface
- Base
- Subbase
- Soil
Assessing Pavement Condition: Pavement Condition Index (PCI)

- **Very Good - Excellent**: At 100
- **At Risk**: 70
- **Fair**: 50
- **Poor/Failed**: 25

The image on the right shows examples of pavement conditions corresponding to each PCI level.
Two Pavement Damage ($$) Estimation Methods

- Pavement Condition Index (PCI) Drop (Visible)
- Structural Assessment/“Use of Life” (Not/min. visible)

- Pick one - can’t do both methods together
PCI Drop Damage Estimation Method

- Pavement Condition Index Drop
  - Based on knowledge of visible distress pre and post fire
  - Change in PCI may yield change in Agency maintenance
  - Subsequent increase in maintenance needs and moves maintenance window forward
  - Difference in cost between treatment needs pre/post fire
  - Simplistic method and ‘advanced’ method
  - Distress is often a “lagging indicator” of overall condition
Example Agency Decision Tree

PCI Thresholds

100
90
70
50
25
0

Costs known for each treatment

I

Do Nothing

II

Slurry Seal

Cape Seal

Thin Overlay

III Load

IV

Thick Overlay/ Mill & Fill/ CIR

V

Reconstruct / FDR

Maintenance Philosophies

**Simplified Example: PCI Drop Method**

- **Slurry - $3/SY**
- **Cape Seal - $7/SY**
- **Damage = 10,000 x (7-3) = $40,000**
- **If no PCI drop -> $0**
- **Advanced method allows for damage calculation if no change in categories (ex. drop from 89 to 72)**

- **10,000 SY of pavement**
- **Pre-Fire PCI 85**
- **Post-Fire PCI 55**
- **Unit cost is difference between slurry seal and thin overlay cost**
- **Total cost is treatment unit cost x pavement area**
Structural “Use of Life” Damage Estimation Method

• Structural Assessment/“Use of Life”
  – Does not depend on measurement of visible distress
  – Concept is to assess how much of the life of the pavement was lost due to fire traffic
  – Cost expressed as a percentage of the value of the pavement
Structural “Use of Life” Method

• Assess pavement structure and value
  – Lengths, widths, layers, thicknesses
  – Subgrade characterization/stiffness
  – Calculate $$ value to replace
  – Based primarily upon fatigue damage
• Estimate design traffic from structure
  – or use design traffic data if available
• Estimate fire-related traffic from number of trucks, truck weights, and distribution (fire trucks, haul trucks…)
• Pavement fire damage = fire traffic/design traffic
• Value of fire damage $$ = pavement fire damage x replacement value
Simplified Example: Structural “Use of Life” Method

- Major collector 10,000 SY designed to handle 200,000 ESALs (Traffic Index = 7.5)
- Replacement Value: $400,000
- Fire-related traffic: 20,000 ESALs
- Fire-related damage = 20,000/200,000 = 10%
- Damage value = 10% x $400,000 = $40,000

- Regardless of any visible distress increase
How Much $$ Should an Agency Expect

• Depends on:
  – Types of roads/streets (classification, thickness, etc.)
  – Network layout of roads/streets and location of fire damage
  – Nature of fire traffic patterns and duration
  – Type of trucks loading pavement

• Not all are fire damage claims are created equal
Example “Distributed” Network

- Two entry/exit points
- Main roads carry traffic for entire network
- Minor roads receive minimal traffic
Example “Railroad” Network

- Caltrans or arterial road carries all in/out traffic
- Collectors only receive traffic for their area
- Minor roads receive minimal traffic
What should an Agency Do?

• Know condition of pavements on continual basis
  – Get regular PCI distress surveys – automated or walking

• Assess conditions immediately after fire
  – For PCI Method
    • Walking or automated survey
    • If automated – remove debris before surveying
    • Take lots of photos – document!
What should an Agency Do?

• Assess conditions immediately after fire
  – For Structural Method
    • Know pavement structure(s) or be willing to measure
      – Layer types, thicknesses, subgrade characterization
    • Document as much about fire-related traffic as possible
      – Truck weights, sizes, start/end locations, fire truck staging areas...
Conclusions

- Fire damage to pavements is a complex topic
- Post-fire pavement damage may or may not be visible
  - Or quantifiable – particularly if you don’t know your pre-fire conditions
  - Therefore - know your network, PCI, thicknesses, materials
- Multiple methods available to assess damage $$
  - Presented two here
- Damage may well continue during rebuilding phase
- Costs increase over time – and you will be rebuilding with future costs
- Document, Document, Document
Thank you!

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