# Pothole Predictive Models Using Traffic and Weather Condition Data

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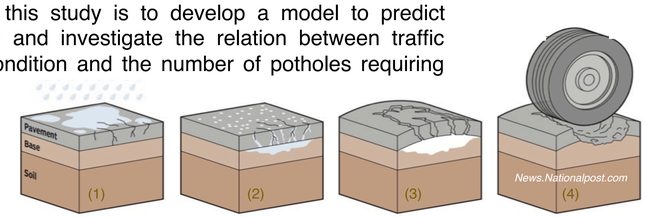
## INTRODUCTION AND MOTIVATION

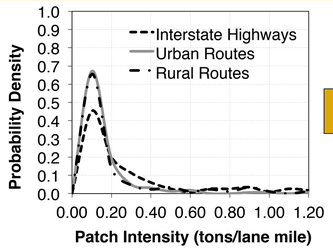
- Potholes are a common pavement distress, particularly appearing during the spring freeze-thaw period in northern climates.
- The reactive approach to pothole repair is not time and cost efficient.
- The objective of this study is to develop a model to predict pothole formation and investigate the relation between traffic loads, weather condition and the number of potholes requiring patching.

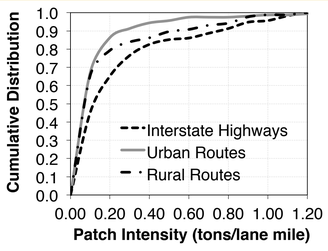

## DATA COLLECTION


- Four cities in different geographical locations
- Sort INDOT highways within fifteen miles of these cities, depending on their functional class, into three groups:
  1. Interstate highways including both rural and urban
  2. Urban US highways and state roads (SR)
  3. Rural SR
- Deriving data from 2011to 2014:
  - Maintenance (patch intensity) → WMS (Work Management System)
  - Weather records → Weather Underground website
  - AADT→ INDOT traffic database

## METHODOLOGY




Probability density function for each pavement segment




Cumulative distribution function for each pavement segment

## ESTIMATION RESULTS

- Interstate highways (including both rural and urban):

$\ln(\Delta patch) = -6.30 + 0.53 \ln(\Delta AADT) + 0.05\,(FT) + 1.07 \ln(CD)$

- Urban routes (including both US highways and SR):

$\ln(\Delta patch) = -1.46 + 0.50 \ln(\Delta AADT) - 0.15\,(T) + 3.27\,(CD)$

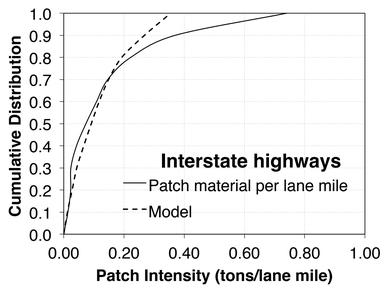
- Rural routes:

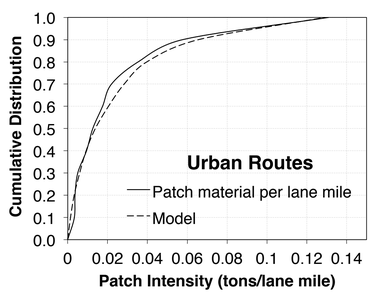
$\ln(\Delta patch) = 5.61 + 0.0002\,(\Delta AADT) - 0.26\,(T) + 5.88\,(CD)$

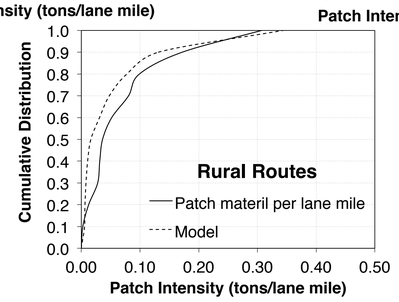
*Δpatch: increment in patch intensity (tons/ lane mile); ΔAADT: increment in AADT (vehicles/ day); T: temperature (F); FT: Number of freeze-thaw cycles; CD: Cumulative distribution.*

The adjusted $R^2$ for the models are 0.56, 0.32 and 0.28 for the interstate highways, urban and rural routes models, respectively.

## EVALUATION OF THE MODELS

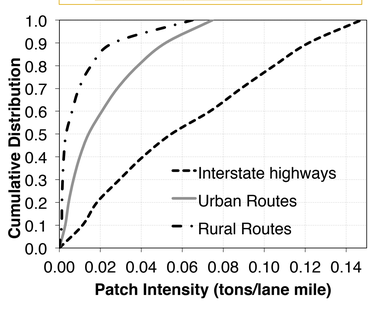


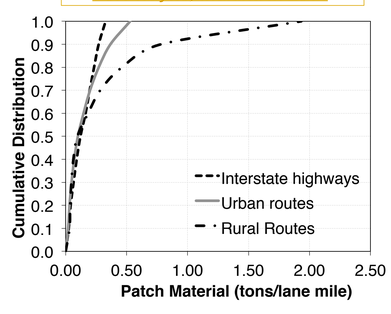




## IMPLICATIONS OF THE MODELS

Mean AADT: 11,098 vehicles per day
Temperature: 60 F
Number of freeze-thaw cycles: 16
"*Evansville, Indiana in 2012*"



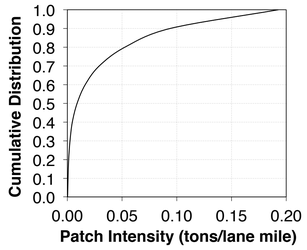

Mean AADT: 11,098 vehicles per day
Temperature: 48 F
Number of freeze-thaw cycles: 32
"*Fort Wayne, Indiana in 2014*"




## NUMERICAL EXAMPLE

SR route segment near Gary, Indiana in 2012

| CD (cumulative distribution) | AADT | ΔAADT | Temperature (F) | ln(Δpatch) | Δpatch intensity | Patch intensity |
|---|---|---|---|---|---|---|
| 0.0 | 2707.4 | 2707.4 | 55.00 | -8.1485 | 0.0003 | 0.0003 |
| 0.1 | 3092.7 | 385.3 | 55.00 | -8.0249 | 0.0003 | 0.0006 |
| 0.2 | 3308.7 | 216.0 | 55.00 | -7.4708 | 0.0006 | 0.0012 |
| 0.3 | 4448.9 | 1140.2 | 55.00 | -6.6980 | 0.0012 | 0.0024 |
| 0.4 | 5358.5 | 909.6 | 55.00 | -6.1561 | 0.0021 | 0.0045 |
| 0.5 | 6927.1 | 1568.6 | 55.00 | -5.4363 | 0.0044 | 0.0089 |
| 0.6 | 8234.2 | 1307.1 | 55.00 | -4.9006 | 0.0074 | 0.0163 |
| 0.7 | 9327.3 | 1093.1 | 55.00 | -4.3554 | 0.0128 | 0.0291 |
| 0.8 | 10483.0 | 1155.7 | 55.00 | -3.7549 | 0.0234 | 0.0525 |
| 0.9 | 11549.0 | 1066.0 | 55.00 | -3.1848 | 0.0414 | 0.0939 |
| 1.0 | 14028.0 | 2479.0 | 55.00 | -2.3142 | 0.0988 | 0.1927 |




## LIMITS

- Even though the models show a good match between the estimated values and the actual corresponding records of patch material per lane mile, the effect of pavement condition cannot be disregarded for the initiation and progression of potholes.
- Models have the ability to explain up to 56% variability in the data set. Although a high variability in the data set presents, the adjusted $R^2$ would most probably increase if other variables that can affect patch intensity were included (e.g.- pavement condition, distress severity, etc.) and data separated for different patching methods.

## CONCLUSIONS

- Traffic load plays a more important role in formation of the potholes in the urban and rural interstate highways compared to the urban US highways and urban and rural SR routes.
- Temperature is more important than the traffic loads in formation of the potholes in rural routes.
- Applying these models can help agencies assign maintenance priority to highways predicted to develop comparatively more potholes, depending on geographical location, traffic loads, and weather conditions.

## FUTURE WORKS

- Developing a model that includes a comprehensive influencing factors, both external and internal; External factors such as traffic and weather condition and internal factors such as pavement thickness, structure, age and pavement material properties (e.g., air void content and binder and aggregate characteristics)

***Acknowledgement***

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