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THE STATE UNIVERSITY OF NEW JERSEY

Elimination of Weight Restriction on Amtrak, NJ Transit, and Conrail Lines

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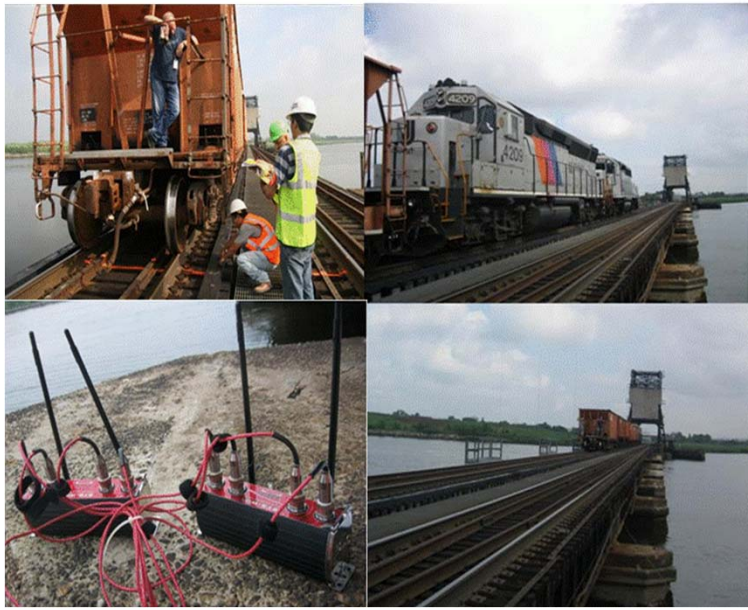
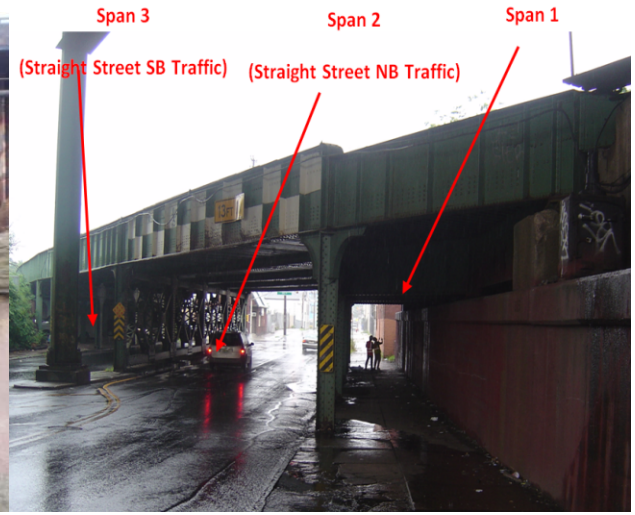
Objectives

- Evaluate current conditions of selected railroad bridges in New Jersey to allow travel of 286-kip freight railcars.
- Provide general guidelines for bridge evaluation and maintenance.
- Make recommendations for appropriate strengthening of the bridges. Include Cost/Benefit Analysis.

NJ Transit Bridges

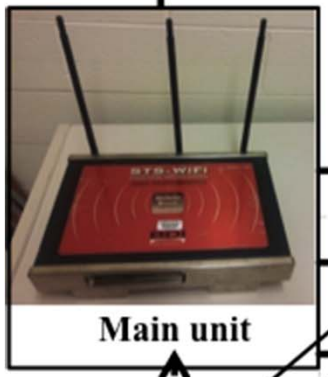
1. Bergen County Line MP 5.48.
2. Main Line MP 15.95.
3. Main Line MP 15.14.
4. Raritan Valley Line MP 31.15.
5. North Jersey Coast Line MP 0.39.



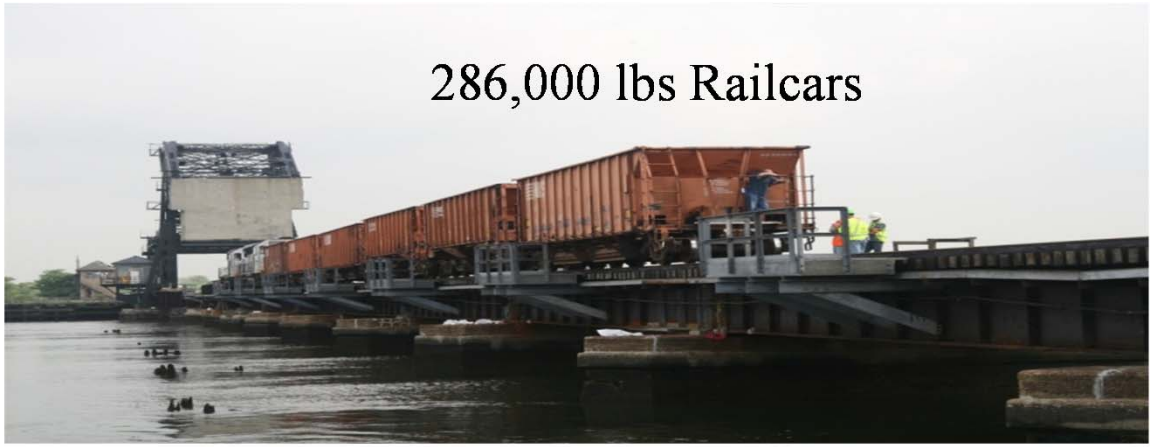


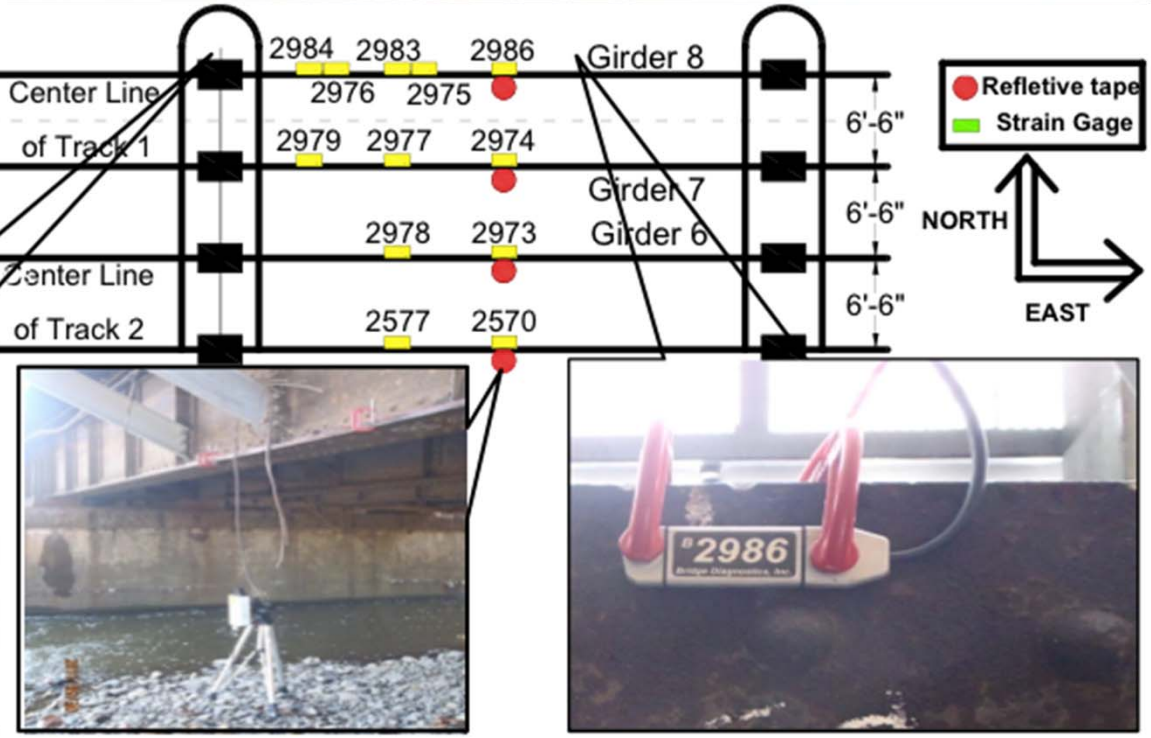
Field Testing and Results

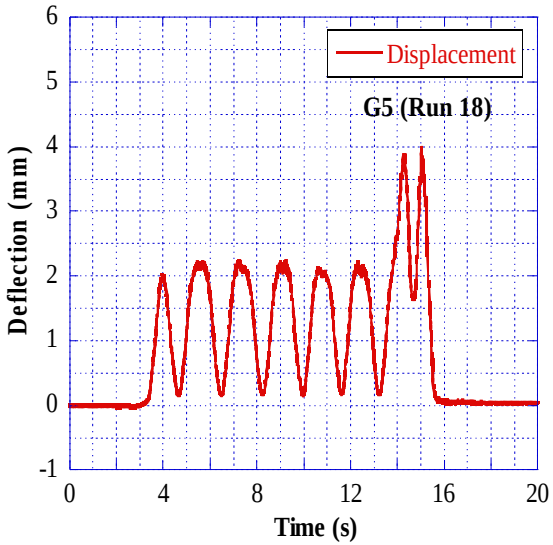
Wireless



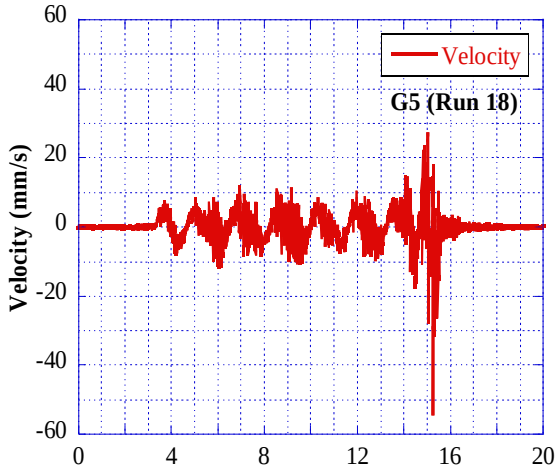
Wireless







• ***Deflection***

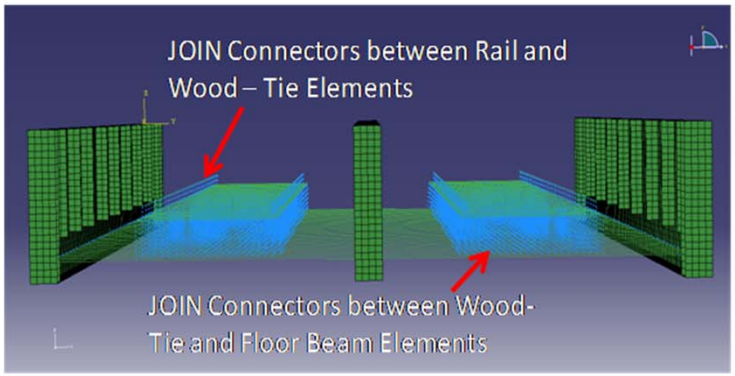


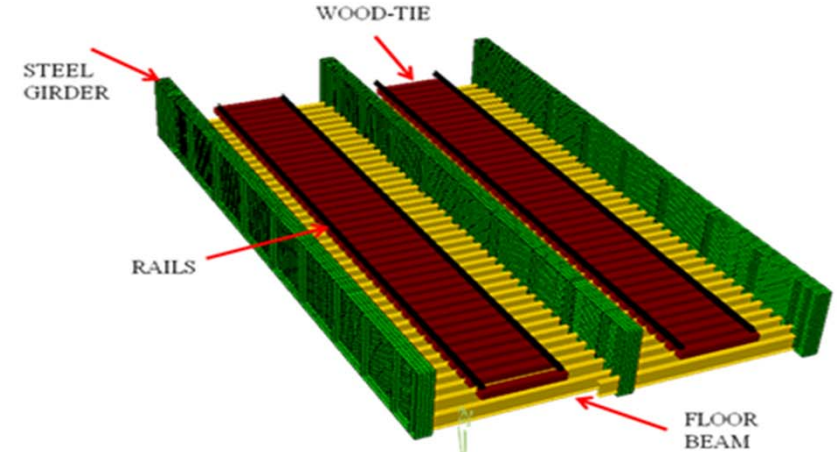
• ***Velocity***

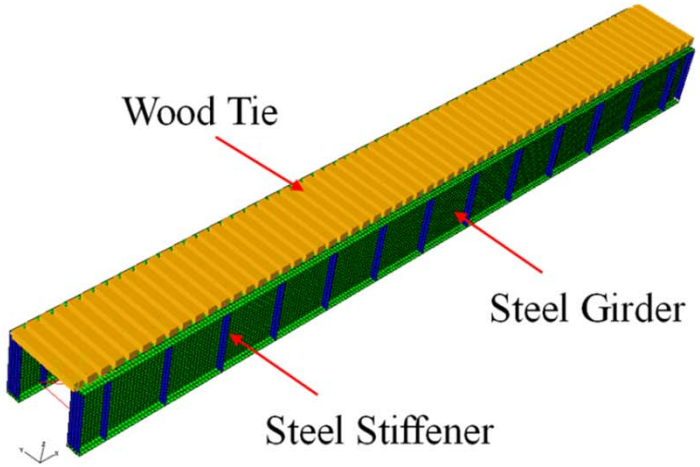
Finite Element Model

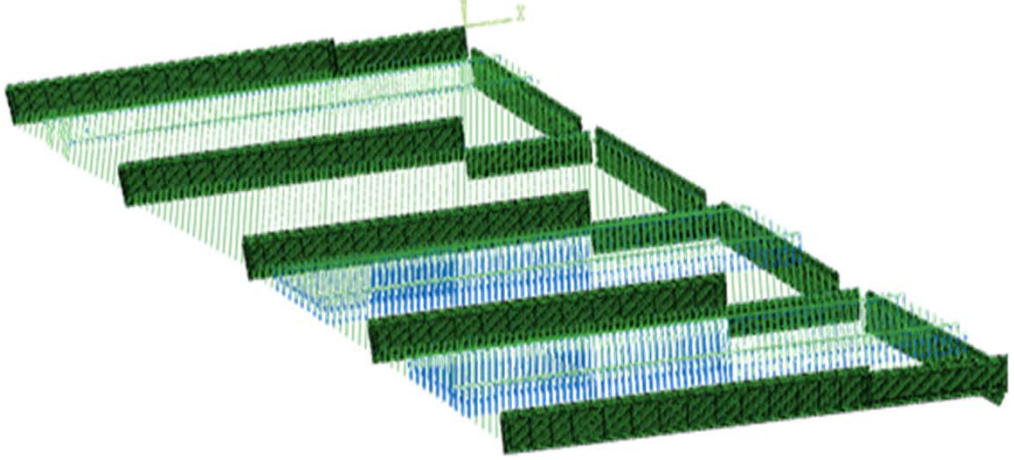
- **ABAQUS Software is used for the analysis, and it allows to model using detailed material properties**

- **Both as-built and as-inspected models were developed and analyzed using various loading scenarios.**







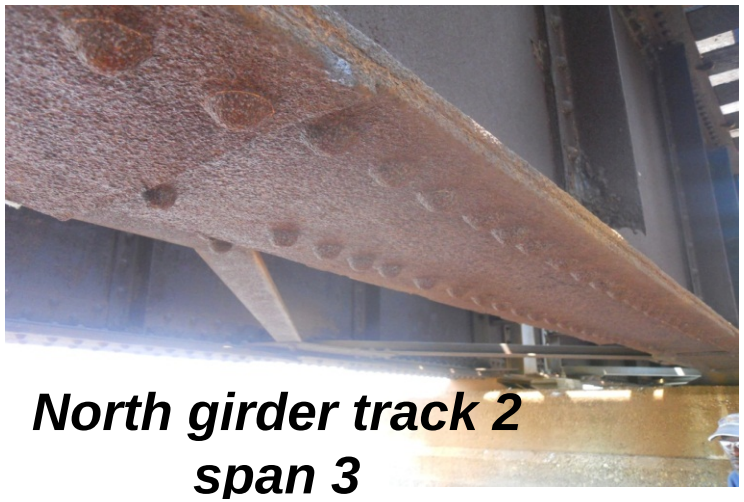


Conclusion for Bergen County Line MP 5.48

- For this bridge, the rating of the bridge was improved and demonstrates higher rating results than the latest inspection report (HNTB Corporation, 2006) after the recent repair (conducted after 2007) by NJ Transit.

- In order to safely carry 286-kips railcars, repairs have to be made to various structural elements. Various repair alternatives were proposed, including adding cover plates to the bottom flange and limiting the maximum speed.

- The feasibility of repair alternatives presented in this report needs to be evaluated and reviewed by NJ Transit.



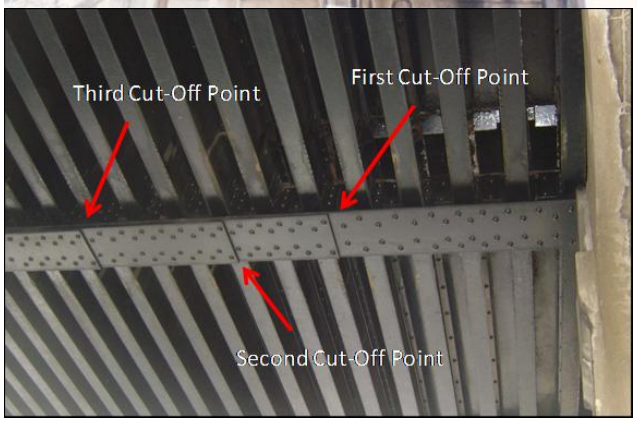
North girder track 2 span 3

Conclusion for Bergen County Line MP 5.48, Cont'd (repair recommendation)

Location	Current S(bot) in^3	Recommended S (bot) in^3	Recommendation (demand over capacity less than 100%)	Recommendation (demand over capacity less than 80%)
Midspan, NG, T2, S3	2,350	2,506.7	Add 1/4 in. thickness cover plate to the bottom	Add 1.13 in. thickness cover plate to the bottom
Midspan, SG, T2, S3	2,250	2,506.7	Add 3/8 in. thickness cover plate to the bottom	Add 1.28 in. thickness cover plate to the bottom
Midspan, NG, T1, S3	2,334	2,506.7	Add 1/4 in. thickness cover plate to the bottom	Add 1.15 in. thickness cover plate to the bottom
Midspan, SG, T1, S3	1,938	2,506.7	Add 7/8 in. thickness cover plate to the bottom	Add 1.75 in. thickness cover plate to the bottom
Midspan, NG, T2, S2	1,977	2,506.7	Add 7/8 in. thickness cover plate to the bottom	Add 1.7 in. thickness cover plate to the bottom
8.5' from support NG, T2, S2	1,210	1,320	Add 1/4 in. thickness cover plate to the bottom	Add 1 in. thickness cover plate to the bottom

Conclusion for Main Line MP 15.95

- ***Overall, the Main Line MP 15.95 Bridge is in good condition.***
- ***The load rating based on FE modeling indicates the bridge is capable of carrying 286 kips railcar.***
- ***However, based on the load rating results using AREMA's simple beam analysis, there is a need to upgrade the through girders in span 2 in order to satisfy a level of demand over capacity (D/C) ratio of 80%.***
- ***Rating results using AREMA approach is lower than those obtained by the FE analysis because the assumed boundary conditions in FE analysis are pinned supports.***



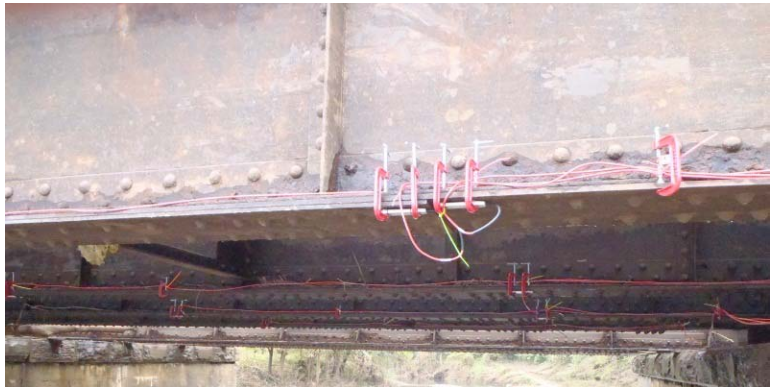
Conclusion for Main Line MP 15.14

- ***For Main Line MP 15.14, the critical member (FB20) is under the abandoned track and will not affect the performance of the bridge directly.***
- ***The load rating based on the FE analysis indicates that the bridge is capable of carrying 286 kips railcar.***
- ***The load rating results using simple beam analysis indicates the load rating of Girder 28 and 29 is fairly close to demand over capacity ratio of 100%***
- ***Higher load capacity was observed in the FE model since different boundary conditions are assumed in FE and simple beam analysis.***

Location	Current S(bot) in^3	Recommendation
Main Line MP 15.14, FB20	64.2	It is recommended FB 19, 20, and 21 to be replaced.

Conclusion for Raritan Valley Line MP 31.15

- **The bridge is in overall fair condition**
- **The rating results from FE model show that the bridge is capable of carrying 286-kip rail cars.**
- **However, the ratings of some of the sections are fairly close to the limit.**



Location	Current S(bot)* in^3	Recommended S(bot) in^3	Recommendation (demand over capacity less than 80%)
Raritan Valley Line MP 31.15, mid-span, 40' girder	1,145.2	1,380	Add 0.33-in thickness cover plate to the bottom

Conclusion for North Jersey Coast Line MP 0.39

- **Similar to the Raritan Valley Line MP 31.15 Bridge, this bridge is in an overall fair condition.**
- **The rating results show that the bridge is capable of carrying 286-kips railcars.**
- **However, the ratings of some of the sections are fairly close to the limit.**
- **Therefore, repairs are needed to improve the performance of the bridge and maintain an adequate safety margin.**

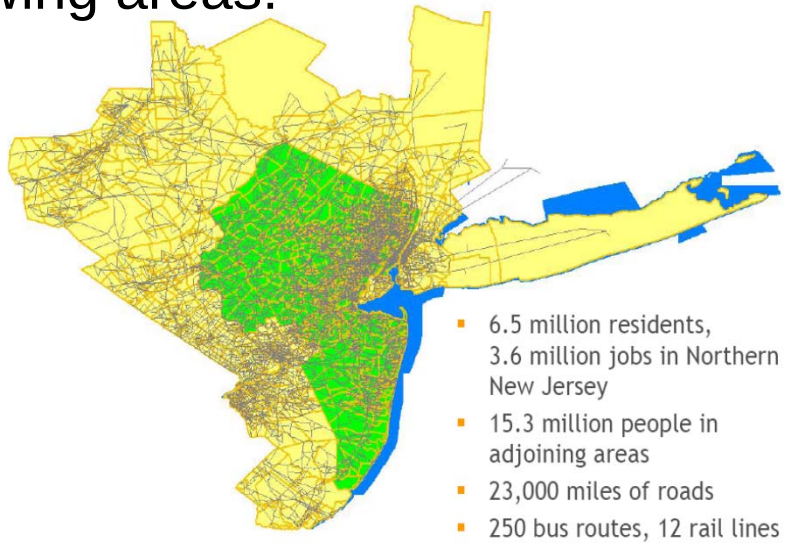
Location	Current S(bot) in^3	Recommended S(bot) in^3	Recommendation (demand over capacity less than 80%)
North Jersey Coast Line MP 0.39, 24.5' from support, 88' girder	3,938	4,600	Add 1 in. thickness cover plate to the bottom
North Jersey Coast Line MP 0.39, mid-span, 88' girder	4,924	5,450	Add 1 in. thickness cover plate to the bottom

Summary of repair cost for accommodating 286-kips railcar load (Based on load rating using FE analysis)

Bridge	Alternative	Description	Repair Cost
Bergen County Line MP 5.48	Cover Plate—100% Demand/Capacity Ratio	Add steel cover plates to the bottom flanges of existing through girders	$2.92 million
Bergen County Line MP 5.48	Cover Plate—80% Demand/Capacity Ratio	Add steel cover plates to the bottom flanges of existing through girders	$5.88 million
Main Line MP 15.14	Cover Plate—100% Demand/Capacity Ratio	Various structural steel repairs to floor-beams and girders	$0.98 million
Raritan Valley MP 31.15	Cover Plate—80% Demand/Capacity Ratio	Add steel cover plates to the bottom flanges of existing through girders	$0.86 million
North Jersey Coast MP 0.39	Cover Plate—80% Demand/Capacity Ratio	Add steel cover plates to the bottom flanges of existing through girders	$9.63 million

Cost of Transport in New Jersey Research

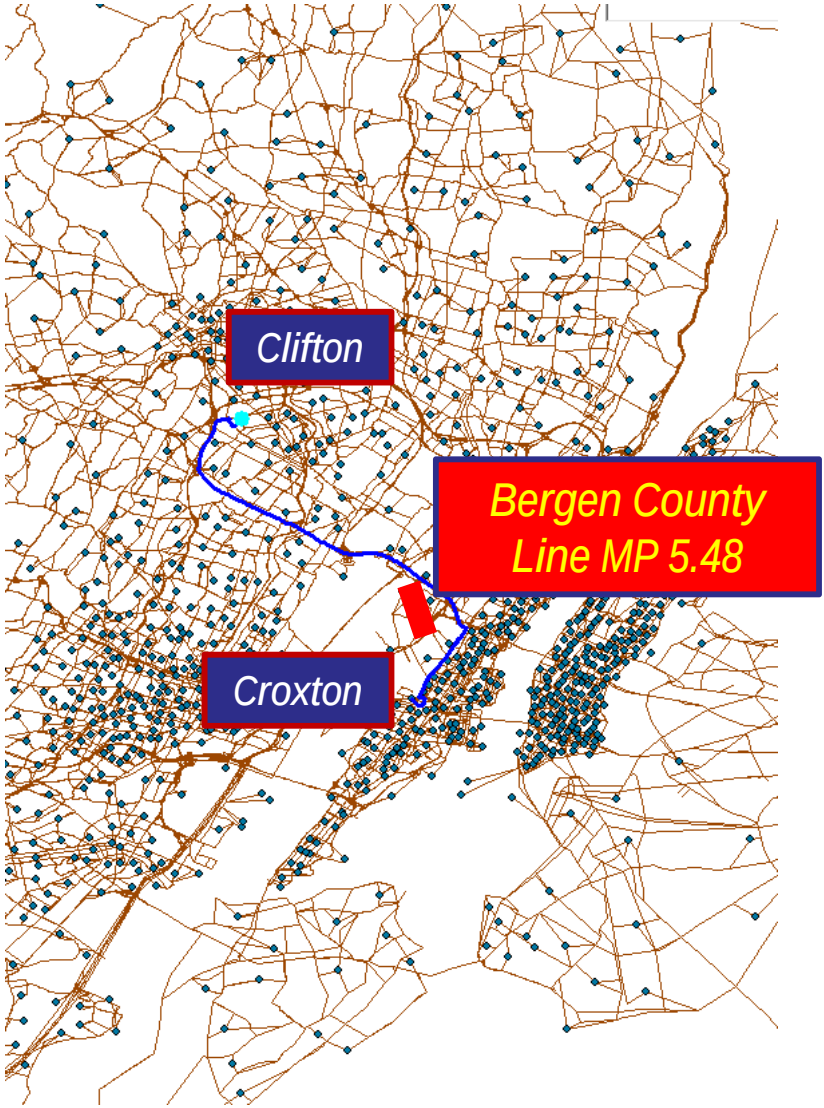
- Based on previous research, cost savings of removing trucks from NJ highways are estimated in the following areas:
  - Operating costs
  - Congestion costs
  - Accidents costs
  - Pollution (Air & Noise) costs
  - Maintenance costs



- 2010 North Jersey Regional Travel Model – Enhanced (NJRTM-E)
- NJ Cost research estimates link-based travel costs for all vehicles traveling on a link as assigned by NJRTM-E, based on parameters such as:
  - Link Type
  - Volume, Capacity
  - Travel Time, Speed

Calculation of Highway Costs

- **Trip** costs aggregated for links along the **shortest path** between an origin-destination (O-D) pair
- **Total Cost (C)** estimates the costs for all vehicles on a given link
- **Average Cost (AC)** is calculated per vehicle
- **Marginal Cost (MC)** estimates the rate of change in costs to all vehicles due to the addition of another vehicle
  - For example, the change in cost to all users of a route by adding a truck along the route
  - Marginal cost is highly variable between congested and uncongested conditions



Shortest Path Calculation

Methodology

- **Scenario A:** ***Anticipated conversion of truck traffic to rail on Bergen County Line MP 5.48 due to 286k***
  - **Assume** 286k rating (from 263k) results in an 8% increase in rail traffic which is otherwise currently moved by truck
  - **Benefits** are calculated from the effect of removing truck trips from the network
  - Freight trips originating/terminating in Croxton, NJ remain on Class I Rail
  - Data from 7/1/10 – 12/31/10 from NJ Transit
    - 44 origin-destination pairs, 8,439 carloads
- **Scenario B:** ***Case Study of Bay State Milling (Clifton, NJ)***
  - Potential for Bay State Milling to move **out of state** (PA/NY) and truck their goods to customers in New Jersey
  - **Benefits** calculated from difference between current trucking and future trucking from out-of-state origins
  - Data from Bay State's customer list (7/1/10 – 12/31/10)
    - 62 customers (NJ & Downstate NY), 5,592 deliveries

Scenario A: Conversion of Truck Traffic to Rail on Bergen County Line MP Benefits

- **Total Average Cost (cost of the truck trips)**

Total Average Cost	Value of Time $25/hr		$35/hr	
	min	*max*	*min*	*max*
Annual Benefit	$68,403	$101,049	$88,247	$133,578
Total benefit (25 years)	$722,505	$1,067,325	$932,110	$1,410,913
Per Truck Trip	$19.49	$28.79	$25.14	$38.06

- **Total Marginal Cost (additional cost imposed on all users of the links along the truck's route)**

Total Marginal Cost	Value of Time $25/hr		$35/hr	
	min	*max*	*min*	*max*
Annual Benefit	$199,847	$3,283,666	$271,439	$4,589,185
Total benefit (25 years)	$2,110,882	$34,683,680	$2,867,073	$48,473,201
Per Truck Trip	$56.94	$935.52	$77.33	$1,307.46

Scenario B: Bay State Milling Deliveries Net Benefit

- Total Average Cost (cost of the truck trips)

Total Average Cost	Value of Time			
	$25/hr		$35/hr	
	min	*max*	*min*	*max*
Annual Benefit	$ 0.13 million	$ 0.55 million	$ 0.16 million	$ 0.71 million
Total benefit (25 years)	$ 1.37 million	$ 5.81 million	$ 1.74 million	$ 7.49 million
Per Truck Trip	*$ 11.56*	*$ 49.16*	*$ 14.74*	*$ 63.43*

- Total Marginal Cost (additional cost imposed on all users of the links along the truck's route)

Total Marginal Cost	Value of Time			
	$25/hr		$35/hr	
	min	*max*	*min*	*max*
Annual Benefit	$ 0.04 million	$ 8.71 million	$ 0.03 million	$ 12.16 million
Total benefit (25 years)	$ 0.39 million	$ 92.01 million	$ 0.29 million	$ 128.49 million
Per Truck Trip	*$ 3.34*	*$ 778.89*	*$ 2.47*	*$1,087.68*

Summary

- In this report, a comprehensive study was performed for five typical bridges owned by NJ Transit. For each bridge, a 3-D FE model was developed. Field experimental study was performed to collect the structural responses. Except for regular passenger railcars, a typical 286-kip railcar was used to perform the field tests on the Bergen County Line MP 5.48 at various speeds. The load rating was performed using both AREMA provisions and FE analysis. Based on the load ratings of various structural members, recommendations for appropriate strengthening of the bridges and the cost were proposed.

- The fatigue analysis performed in this study indicated that the remaining fatigue life of the bridges would be reduced by 17 to 27 years if the 286-kips freight railcars were utilized. Thus, In order to evaluate the long term performance of the bridge and take advantage of in-place sensors, further data collection and long term structural monitoring before and during operation of 286-kips railcars are recommended.

Summary

- The analysis showed a potential benefit of up to $7.49 million over 25 years. It is important to note that this is only for Bay State Milling's potential moving-out-of-state scenario, and measures only transportation impacts and no other significant economic measures. Also, it was noted that Bay State Milling represents 30 percent of traffic travels on Bergen County Line MP 5.48. If the same assumptions were applied to all traffic on Bergen County Line MP 5.48, the transportation-related benefits of 286-kip railcars could be as high as $25 million over 25 years. It is also important to note that this is only one line carrying freight traffic in New Jersey.

- Currently, NJDOT is also considering operation of 286-kips freight railcars on other lines in NJ. These structures should be inspected, modeled, and load-rated to allow for 286-kips freight railcars and improve the freight-rail network in New Jersey. Maintenance, repair, and retrofit recommendations are needed to facilitate the heavier rail cars.

Acknowledgements

- ***NJ TRANSIT: Chuck Maliszewski, Chief Engineer, David Dieck, Director, Contract Administration – Rail Operations, and Paul Falkowski, Project Engineer***
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