James River Bridge Roadway Safety Audit

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COMMONWEALTH OF VIRGINIA
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Traffic Engineering has performed a safety study on the James River Bridge with specific attention paid to the steel grid deck. This safety study included a crash analysis, sight distance evaluation, and speed and volume data collection and analysis.

Background

In the fall of 2012, the steel grid deck on the James River Bridge lift span was replaced. The replacement was completed Dec 15, 2012. To maintain traffic during the installation, a crossover was constructed by removing a section of the median barrier directly south of the grid deck. When not in use, the median barrier opening is spanned by tubular markers, and has impact attenuators installed on each end of the exposed barrier.

Two months after the installation an increase in crashes was observed on the new grid deck. Table 1, below and on the next page, shows a summary of the crashes that have occurred since the installation of the grid deck. Observations include that the majority of the crashes have been in the southbound direction, occur during wet weather, and involve a light truck or SUV. Crash events were taken from VA Traffic incident database and Isle of Wight County Sheriff's office. Crash reports are from the TREDS database.

Table 1 - Grid Deck Crash Summary

Date	Time	Inj	Pavement	Crash Type	Direction	Vehicle
2/13/2013	7:15	1	Wet	Rear End	SB	Ford Ranger
2/13/2013	20:00	0	Wet	Fixed Object - Off Road	NB	Dodge Dakota
3/12/2013	5:44	0	Wet	Fixed Object - Off Road	SB	Suzuki Sidekick
3/16/2013	23:05	1	Wet	Fixed Object - Off Road	SB	Mazda Miata
3/24/2013	13:31	1	Wet	Fixed Object - Off Road	NB	Dodge Dakota
4/4/2013	20:08	0	Wet	Fixed Object - Off Road	SB	Jeep Cherokee
4/12/2013	9:07	2	Wet	Fixed Object - Off Road	SB	Isuzu Rodeo

Date	Time	Inj	Pavement	Crash Type	Direction	Vehicle
4/12/2013				*Rear End*		*Stopped traffic - Not grid deck related*[1]
4/19/2013	6:58	0	Wet	Fixed Object - Off Road	SB	Mazda Miata
4/19/2013	7:14	1	Wet	Fixed Object - Off Road	SB	Honda Accord
4/20/2013				*Rear End*		*Stopped traffic - Not grid deck related*[1]
4/24/2013	15:50	1	Dry	Fixed Object - Off Road	SB	Mazda6
4/29/2013	5:04	0	Wet	Sideswipe - Same Direction	SB	Isuzu Rodeo
4/29/2013	6:03	2	Wet	Sideswipe - Same Direction	SB	Ford Explorer
5/23/2013	7:05	0	Wet	Fixed Object - Off Road	SB	Chevrolet Cobalt
6/22/2013	14:50	1	Dry	Fixed Object - Off Road	NB	Nissan Frontier
6/27/2013	17:43	3	Wet	Sideswipe/FO-OR[2]	SB	Nissan Frontier
7/1/2013	10:15	1	Wet	Fixed Object - Off Road	SB	Infiniti QX4
7/1/2013	20:24	F[3]	Wet	Fixed Object - Off Road	SB	Ford Explorer
7/7/2013			*Dry*		*NB*	*DUI - Not Grid Deck Related*

[1] Traffic was stopped on the grid deck for an earlier accident downstream (4/12) or disabled vehicle (4/20). While the crash occurred on the grid deck, the majority of the braking occurred before the deck on the uphill side.
[2] The first crash was a sideswipe-same direction, but that vehicle then struck the median barrier, causing the majority of the damage.
[3] Fatality

It should be noted that when assembling this summary, the crash types were determined from the Crash Diagram and Description in the FR300 police reports. In several instances crashes that were more properly categorized as Fixed Object-Off Road crashes were recorded by the investigating officer as an angle or sideswipe crash.

In addition to looking at the specific crashes that occurred on the grid deck since replacement, a comparison of historical rates on the grid deck and on the bridge as a whole was made. Table 2, on the next page, shows that comparison. Total crashes from 2007 through 2012 are from the RNS database. 2013 counts are from the same sources as above. As can be seen from the table, from 2007 to 2012, the crash rate on the grid deck remained relatively constant.

Statistically, the bridge outside of the grid deck is currently on track to have its safest year on record, but the crashes on the grid deck have experienced a statistically significant spike in 2013. AADT for 2013 is not yet available, but given the historical trend it is likely to be within a few percent of 2012. For the grid deck, the statistically significant "spike" indicates that some other issue has caused the crash rate for this year to exceed that which could reasonably be expected due to simple random variation.

Table 2 - JRB Crash History

Year	AADT[1]	Bridge[2]	Grid Deck	Total
2007	28,978	33	3	36
2008	28,341	17	1	18
2009	28,580	26	4	30
2010	27,201	12	3	15
2011	28,504	24	0	24
2012	28,107	40	2	42
2013	---	2	20	22

[1] Annual Average Daily Traffic
[2] The crashes for "Bridge" are exclusive of crashes that occurred on the grid deck.

Due to the high rate of crashes occurring during wet weather, the frequency of precipitation in 2013 was compared to earlier years. The Community Collaborative Rain, Hail and Snow Network (www.cocorahs.org) was consulted for this information. Table 3, below, presents the data from that investigation.

Table 3 - Rainfall per Month

	Days of Rain		
Month	2011	2012	2013
January	8	8	13
February	10	9	9
March	13	14	7
April	9	8	8
May	8	15	13
June	8	9	12

As can be seen from the table, 2013 did not experience significantly more rainfall events than either of the previous two years. In fact, April, which saw the greatest number of crashes, had the same rainfall in 2013 as in 2012.

Sight Distance

On Sunday, July 7, 2013, Traffic Engineering staff measured the sight distance across the vertical curve of the grid deck, to ascertain whether limitations in visibility could be contributing to the elevated crash rate. A total sight distance across the grid deck of **639 feet** was measured in both directions. This **exceeds** the minimum required stopping sight distance of **495 feet** for 55 MPH and **360 feet** for 45 MPH as reported in Table 3-1 of the AASHTO *Policy on Geometric Design of Highways and Streets* – the "Green Book."

Traffic Speeds and Volumes

Traffic speeds were measured by means of a Wavetronix radar measurement and permanent inductive loop collectors for two consecutive 24-hour periods on July 16 and 17, 2013. Data collection took place during clear, dry weather. A single lane closure in each direction was in effect in the vicinity of the Wavetronix collector for a short period each of each day that data was collected. Speeds during these lane closures were discounted from the Wavetronix data, but volume was still collected. Total volume for **7/16/2013** was **31,400 vehicles**. Total volume for **7/17/2013** was **31,350 vehicles**. Table 4, below, presents the speed data collected. The 85%, Median and Pace speeds measured match with a shorter radar study performed earlier in July.

Table 4 - Speed Data

Route 17 Speed Data			
Sample Location	85th Percentile Speed	Median Speed	Pace Speed
80' S of Grid Deck – NB (Wavetronix)	61	54	55-65
80' S of Grid Deck – SB (Wavetronix)	60	52	55-65
South End of Bridge – NB (Loop Detector)	57	52	50-60
South End of Bridge – SB (Loop Detector)	54	48	50-60

Mitigations

According to seminal research published in FHWA Public Roads, causes of crashes are categorized into human factors, mechanical failures, and roadway deficiencies. Research has shown that human factors generally play a disproportionate role in most crashes, often the sole cause of a crash. Even so, improvements in the other two factors can help make up for lack in the third. Just as one should drive with extra caution when a vehicle is deficient in some way, improvements to roadways and roadside environments can and have improved the safety records of otherwise increasingly distracted drivers. Likewise, a small deficiency in one factor can expose larger deficiencies in the other factors.

Approximately 30,000 drivers each day safely navigate the James River Bridge, even during inclement weather. Even so, the crash records indicate that something statistically significant changed between 2012 and 2013. The most significant change in that time is the installation of the new grid deck on the lift span.

Given these facts, there are two approaches available to increasing the safety of this roadway segment: increase the safety of the roadway environment or alter the behavior of the drivers.

Increasing the safety of the roadway environment would involve increasing the friction and skid resistance of the grid deck. This is a design issue that will not be further explored here, other than to say that it is likely to be the more effective solution.

The purview of Traffic Engineering is to implement traffic control devices that may assist in modifying the behavior of drivers. In this case, an actual reduction in traffic speeds is what will most likely increase the safety of this segment. Unfortunately, changing traffic speeds is not a straightforward

procedure. To this end, in early May Variable Message Sign (VMS) messages indicating an advisory 45 MPH speed limit were implemented during wet weather. In addition, in June, a Virginia State Police (VSP) presence has been arranged for during wet weather.

To further reinforce the advisory message, Slippery When Wet (W8-5) signs with STEEL DECK (W8-5bP) supplemental plaques can be installed on each approach to the grid deck. STAY IN LANE (R4-9) signs supplemented by solid double white lane lines can be installed to prohibit changing lanes in the vicinity of the grid deck.

After monitoring the effectiveness of the above measures, physical measures are the next level of invasiveness – so called traffic calming. While most traditional traffic calming measures are intended and only appropriate for low-speed residential roads, Traffic Engineering can offer a few strategies to attempt to limit traffic speeds that have seen successful use at transitions from high-speed to lower-speed roadways in rural applications. The universal down-side to all the traffic calming measures presented below is that they are full-time, not just during wet weather.

Transverse Thermoplastic Rumble Strips

Thermoplastic rumble strips are placed with sufficient thickness to create an auditory and tactile feedback for drivers passing over them. Studies in Minnesota and Ohio have reported statistically significant reductions in speed of 2-8 MPH.

Converging Chevrons

These chevron markings are painted across each lane of travel and decrease in both spacing and thickness, attempting to create a psychological feeling of increased speed. In studies they have shown a 1 to 4 MPH decrease in average speeds for at least 1 year after installation. These could be supplemented by vertical bars painted on the barrier wall similarly decreasing in spacing and thickness.

Summary and Conclusions

There has been a statistically significant increase in the crash rate on the steel grid deck in 2013. Traffic Engineering has presented a variety of options to attempt to adjust driver behavior to help mitigate future crashes.

In conclusion, Traffic Engineering recommends the following steps be taken:

- Continue utilizing VMS to post advisory speeds during wet weather
- Continue arranging for VSP presence during wet weather
- Install SLIPPERY WHEN WET/STEEL DECK signs
- Install STAY IN LANE signs with solid white double lane lines
- Continue to monitor crashes to determine the effect of the above mitigation strategies and modifications to the grid deck to increase friction and skid resistance
- Consider traffic calming measures if the above prove ineffective

References

Federal Highway Administration (FHWA), 2009, *Traffic Calming on Main Roads Through Rural Communities*. FHWA Publication No. FHWA-HRT-08-067.

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