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Load Rating in a Production Environment

Ronald A. Love, PE

Western Bridge Engineers' Seminar



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Discussion Topics

- General overview of load rating
- Methods typically employed
- Load rating on production scale
- What is needed?
 - Data
 - Efficient processes
 - Organizational acceptance
- Examples
- Conclusions
- Benefits



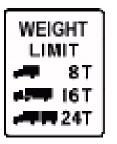


General Overview of Load Rating

- Determination of the safe load carrying capability of a bridge
 THE RATING AND POSTING ****
- 1. For NBI reporting

	******************* LOAD	RATING AND P	OSTING *******	CODE
(31)	DESIGN LOAD	- H-15	OR M-13.5	2
(63)	OPERATING RATING	METHOD -	LOAD FACTOR	1
(64)	OPERATING RATING	i -	MS-14	25.2
(65)	INVENTORY RATING	METHOD -	LOAD FACTOR	1
(66)	INVENTORY RATING		MS-11	19.8
(70)	BRIDGE POSTING	- POSTING R	EQUIRED	2
(41)	STRUCTURE OPEN,	POSTED OR CL	OSED -	Ρ
	DESCRIPTION -	POSTED FOR	LOAD	

- 2. For bridge weight posting
- 3. For OS/OW Permit support





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What Is Load Rating?

- Determination of the safe load carrying capability of a bridge
 THE RATING AND POSTING ****
- 1. For NBI reporting

	****************** LOAD	RATING AND	POSTING *******	CODE
(31)	DESIGN LOAD	- H-1	5 OR M-13.5	2
(63)	OPERATING RATING	METHOD -	LOAD FACTOR	1
(64)	OPERATING RATING	; -	MS-14	25.2
(65)	INVENTORY RATING	METHOD -	LOAD FACTOR	1
(66)	INVENTORY RATING	; •	MS-11	19.8
(70)	BRIDGE POSTING	- POSTING	REQUIRED	2
(41)	STRUCTURE OPEN,	POSTED OR C	LOSED -	Ρ
	DESCRIPTION	POSTED FOR	LOAD	

2. For bridge weight posting

3.For OS/OW Permit support



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Load Rating Tools and Methods

- Many methods used over the years
 - Hand calculations
 - Spreadsheets/MathCAD
 - Semi automation using envelope vehicle (compare vehicle to known rating of std vehicle)
 - Comprehensive computer programs and systems
- Typically methods utilize line girder method of analysis. More refined methods are on the horizon
- Specifications include ASR, LFR and LRFR



Load Rating Software

- Some commonly used original computer systems:
 - BARS (Bridge Analysis and Rating System): Control Data Corp. then AASHTO
 - BRASS (Bridge Analysis of Structural Systems): Wyoming DOT
 - BAR7: PennDOT
 - Virtis: AASHTO
 - LARS (Load Analysis and Rating System): Bentley
 - Others: Merlin Dash, MDX, home grown systems...

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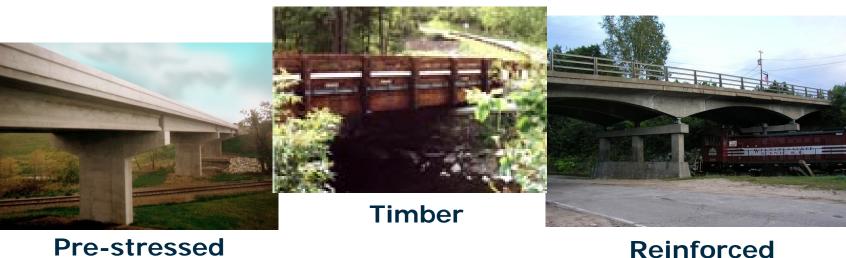


Load Rating on a Production Scale

- Requires processes that perform the functionality of the previously mentioned systems <u>reliably</u> and <u>quickly</u>.
- Maximize use of automation
- The result must be the same as if individual bridges were analyzed one at a time
- Requires data models of each bridge, or a majority of the bridges, in the state's highway network
- Focus (currently) is on routine bridge types



Bridge Types



Concrete

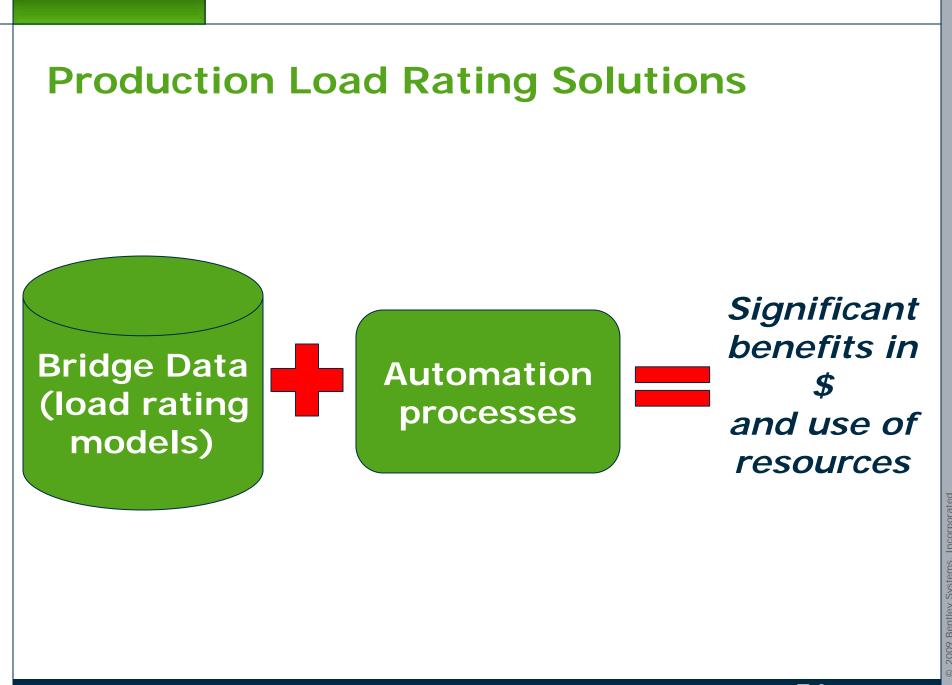
Reinforced Concrete Tee



Reinforced Concrete Slab



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Data

- Data is the key element for production load rating
- Need to support multiple data sources
 - Model efficiently in native system
 - Import from other sources
- Support as many bridge types as possible and add more...
- Primarily focused on common bridge types
- Scale to add more complex bridges in the future





Example Bridge Data Sources

- Model Bridges in Host System (LARS)
 - Arkansas DOT (approx. 1400 bridges in one year on heavy haul routes)
 - Nebraska DOR (approx. 2200 bridges in one year using resources at NABRO (Univ. of Nebraska)
 - Illinois Tollway (approx. 200 bridges in 3 mos.)
- Import from other formats. i.e. LARS Connector extraction of bridges directly from AASHTOWare Virtis
- Import **AASHTOWare BARS** data directly. Thousands of bridges in this form still in use!
- Others as needed....



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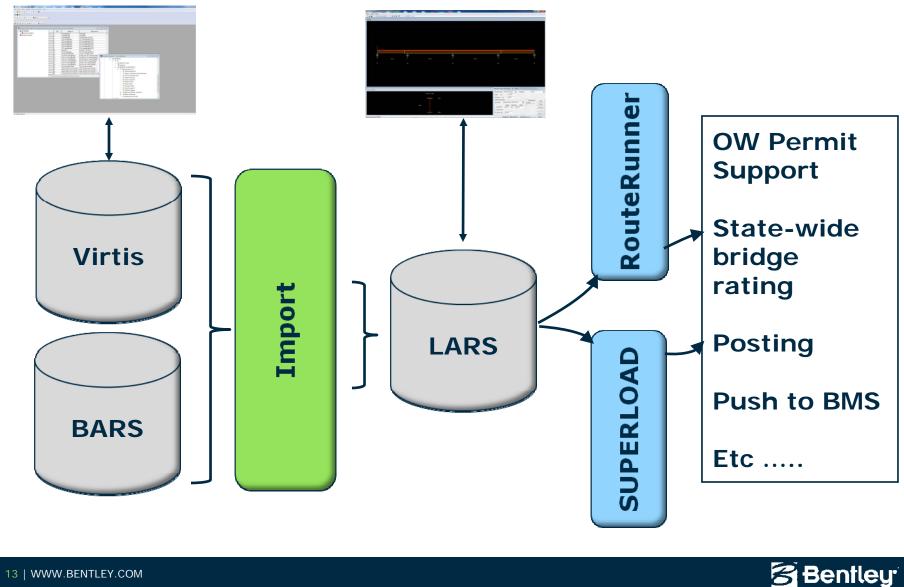
Processes

- Ability to handle the common bridge types
- Current with latest bridge specifications
- Accepted analytical methods
 - Live load distribution factors and influence lines for live load
 - Ability to verify results
- Use stand alone or as part of larger integrated process
- Examples will follow...

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Combining Data and Processes



IDOT/MoDOT Load Rating System

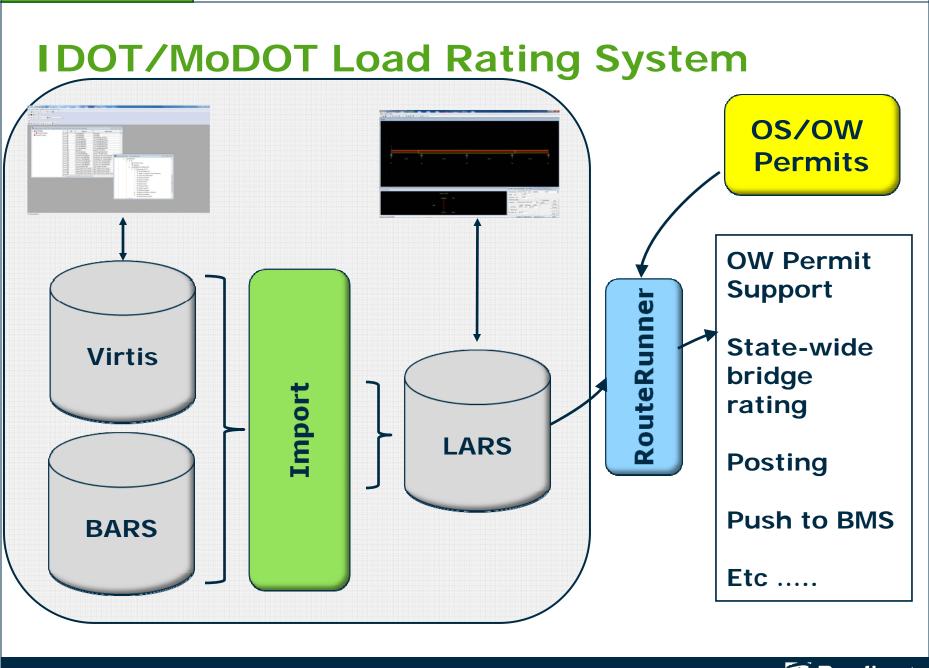
- Using LARS Bridge, both Virtis and BARS data are converted and run by a single process
- The RouteRunner module is linked to the IDOT and MoDOT permit system via the "permit file"
- All bridges are automatically queued and the permit vehicle is applied
- Rating analysis takes place very quickly and results are easily viewed using Excel spreadsheets
- All results are retained for historical archiving
- The system is very easy to use

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IDOT and MoDOT Goals

- Decrease time needed to turnaround permit requests
- Eliminate mainframe usage
- Leverage legacy data sources
- Fit well within their existing operations





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LARS RouteRunner

le Settings Manager	Runner DataChk Help		
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xisting Bridges (6639)		Selected Bridges	
Bridge ID	Source 🔺	Bridge ID	Sour
👍 A0001	Virtis 📃		
4A0003	Virtis		
4A0004	BARS		
4A0005N	BARS		
4A0005S	BARS		
4A0007	Virtis	>>	
4A0008	Virtis [–]		
4A0010	Virtis		
4A0012	BARS		
4A0022N	BARS		
4A0022S	BARS	>>	
4A0024	Virtis [—]		
4A0025	Virtis		
4A0027	Virtis		
4A0028	Virtis		
4A0030	Virtis _	<<	
🛧 A0042	Virtis		
🛧 A0046	BARS		
🛧 A0048	Virtis		
4A0051	BARS		
👍 A0053E	Virtis	<<	
4A0053W	Virtis [—]		
👍 A0056	BARS		
4A0057	BARS _		
* VUUE8	BADQ		
< III	4		



LARS RouteRunner Permit File

	Runner DataChk Help	Q @		
V INDX 🛶 STHP 🔨 🖉	11 ···· List ••2 ·•1 250 250 250	11 - 620		
Existing Bridges (6639)		Selected	Bridges	
Bridge ID	Source 🔺	Bridge II)	Sour 🔺
44 A0001	Virtis 🗉	44 A1240	N	BARS
44 A0003	Virtis	44A1662		BARS
44 A0004	BARS	<u>4</u> A1427		BARS =
44 A0005N	BARS	🚣 A0610		BARS
44 A0005S	BARS	A2142		BARS
44 A0007	Virtis	>> 🗛 A2145		BARS
44 A0008	Virtis	A2147		BARS
44 A0010	Virtis	<u>+</u> A2149		BARS
44 A0012	BARS	<u>++</u> A2150		BARS
44 A0022N	BARS	📥 A2443		Virtis
44 A0022S	BARS	>>> 📥 A2444	E	BARS
44 A0024	Virtis	A2116	E	BARS
44 A0025	Virtis	<u>++</u> A3408		BARS
44 A0027	Virtis	📥 A1346	E	Virtis
44 A0028	Virtis	<	E	Virtis
44 A0030	Virtis	🚣 A0053	E	Virtis
44 A0042	Virtis	📥 L0981	E	Virtis
44 A0046	BARS	📥 L0983		BARS
44 A0048	Virtis	📥 A5075		BARS
44 A0051	BARS	4 L0984	E	BARS
44 A0053E	Virtis	/ </td <td></td> <td>BARS</td>		BARS
₩A0053W	Virtis	📥 L0407		BARS
44 A0056	BARS	🙀 G0388		Virtis
40057 A0057	BARS 🖕	44 L0352		Virtis 👻
*** VUUE8	RADQ	4		
	F	,		

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LARS RouteRunner Results

	A	В	С	D	E	F	G	Н	I	J	К
1	Structure I	Member II	Critical CP	Material o	Impact fac	Rating Typ	Rating Truck	Rating Factor	Rating Factor No impact	Design Me	Rating Method
2	A1240N	G02	3	CPS	0.256	OPER.	1818	1.53	1.92	LFD	Μ
3	A1662N	G03	4	RC	0.3	OPER.	1818	1.17	1.53	LFD	Μ
4	A1427N	S04	4.5	CSC	0.3	OPER.	1818	0.84	1.09	LFD	Μ
5	A0610N	G04	5	CSC	0.185	OPER.	1818	0.96	1.14	LFD	V
6	A2142	S02	2.5	CSC	0.3	OPER.	1818	1.28	1.67	LFD	Μ
7	A2145	01	4.	RE		OPER.	1818	1.3	1.69	LFD	Μ
8	A2147	01	D	RC	0.3	OPER.	1818	0.99	1.29	LFD	Μ
9	A2149	C02	Λ	CSC	0.2	OPER.	1818	0.97	1.26	LFD	V
10	A2150	S01	<u>1.</u> 4	RC	0.3	OPER.	1818	1.86	2.42	LFD	Μ
11	A2443	61	25	69 0	pa	OPER	1818	1.08	1.41	LFD	Μ
12	A2444E	S02	5.	GC	0.3	OFER.	1813	1.27	1.65	LFD	Μ
13	A2116E	602	1.4	CSC	0.3	OPER	1818	1.66	2.16	LFD	Μ
14	A3408	S01	2.5	RC	0.3	OPER.	1818	1.55	2.01	LFD	Μ
15	A1346E	G2	2.5	F		OPER	1819	1.02	1.34	LFD	Μ
16	A1347F	G2	25	CSC	0 3	OF IR.	1:18	L L3	1.47	LFD	Μ
17	A005 <mark>3</mark> F	G3	2.5	CSC	0.3	OPER.	1218	1.02	1.33	LFD	Μ
18	L0981E	G2	1.4	CSC	0.3	OPER.	1818	1.21	1.58	LFD	Μ
19	L0983E	S02		CSC C	0.3	OPER.	1818	1.04	136	LED.	М
20	A5075	G 2		cee	0 25	DPER	1818	<u> </u>		LFU	М
21	L0984E	S01		RC	0.3	OPER.	1818	1.18	1.53	LF)	М
22	L0146	S03	2	CSC	0.3	OPER.	1818	1.08	1.4	LFD	Μ
23	L0407	S05	1.5	SS	0.3	OPER.	1818	1.27	1.65	LFD	<u></u>
24	L0352	4	-	/st	- 3	OPEP.	1813	1)1	1.)	AL.	И
25	A0077	501	/ / y	RC	4 .3	OF EN.	1818	1.08	1.41		Μ
26	A0208E	G02	2.5	CSC	0.3	OPER.	1818	0.93	1.21	LFD	Μ
27	A0110E	S01	3.6	RC	0.3	OPER.	1818	1.29	1.68	LFD	Μ
28	G0517	S11	2	SS	0.256	OPER.	1818	0.93	1.17	LFD	Μ
29	A0207	S02	1.4	SS	0.3	OPER.	1818	1.1	1.43	LFD	Μ



IDOT/MoDOT Load Rating System Benefits

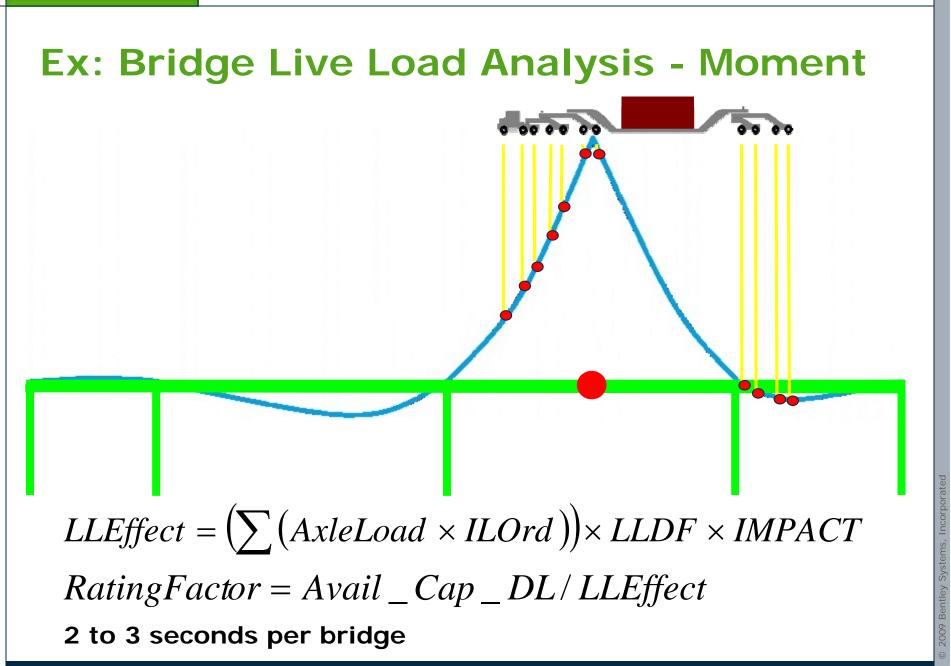
- Eliminated the mainframe saving time and money
- Combined two valuable data sources into a single source
- Greatly reduced the time needed to turnaround permit bridge analysis requests
 - At MoDOT after one year of operation bridge study times went from 2.89 hrs. to 1.13 hrs per permit request
- Also use LARS to feed rating data to the states Transportation management System (TMS)
- Value in the ability to leverage legacy and new bridge data



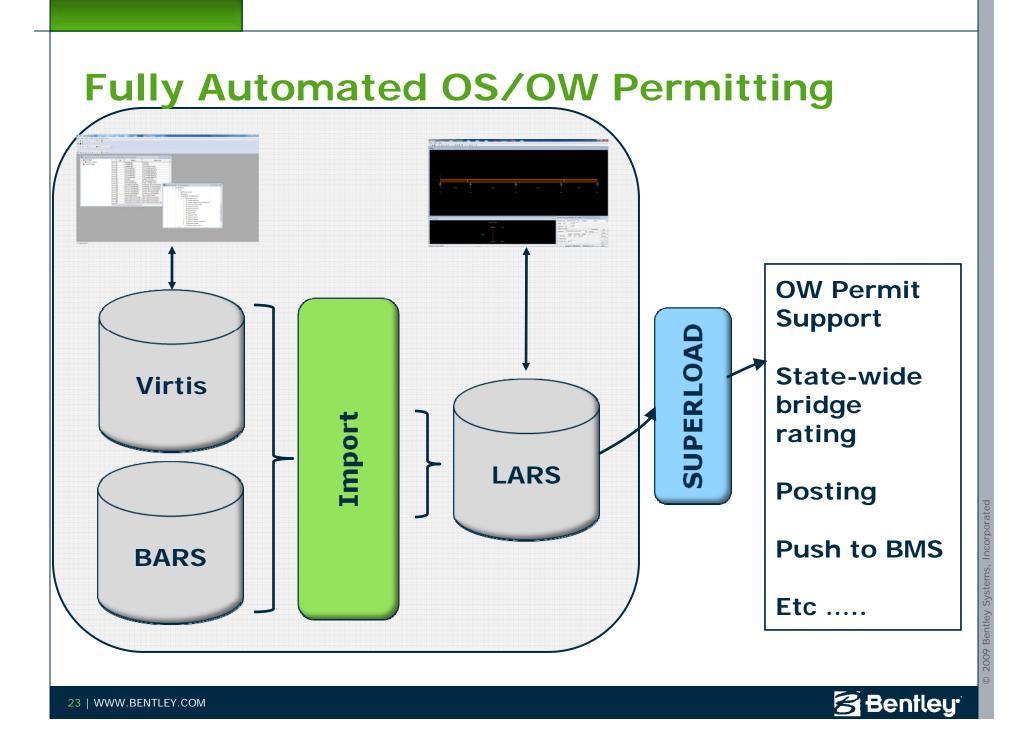
The Automated Live Load Analysis - RR

- For every bridge along the route
- For <u>every member</u> in each bridge <u>check every</u> <u>1/10 point in each span</u>
- Perform moment, shear and serviceability rating for the permit vehicle
- Determine critical rating
- Perform each rating considering full multiple lane full and low impact and single lane full and low impact

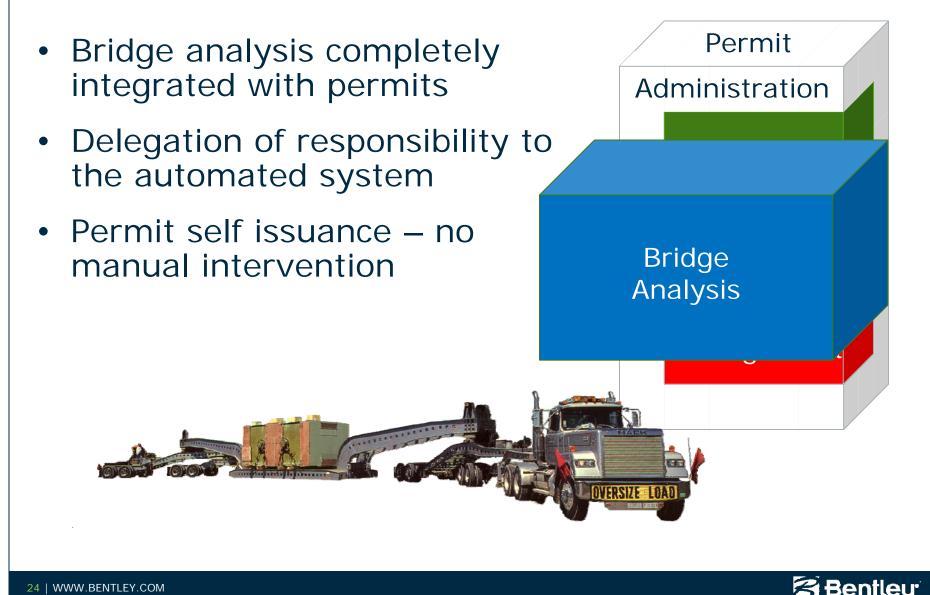








Fully Automated Routing & Permitting



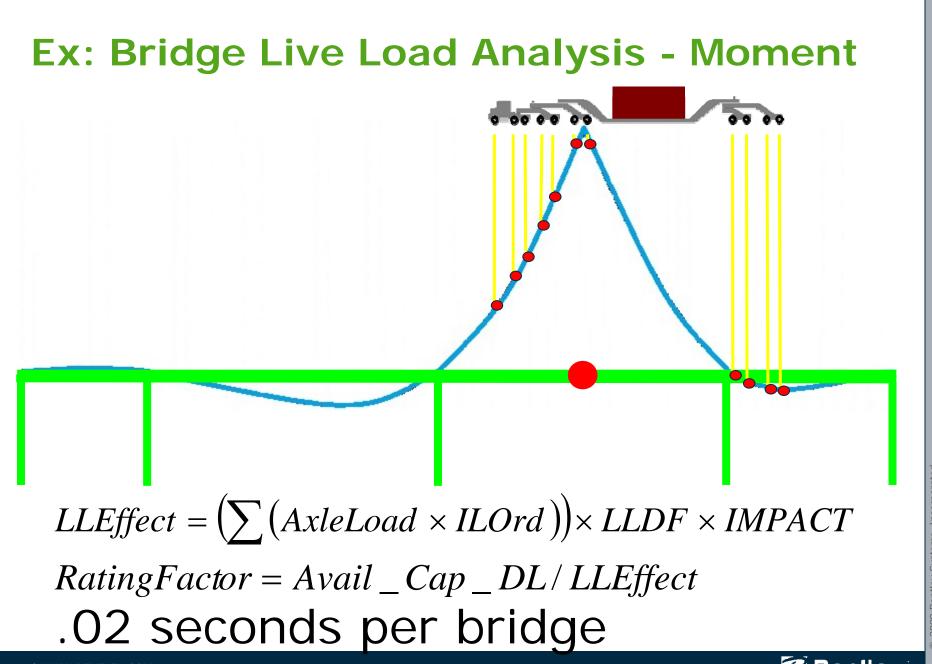
Routing and Bridge Analysis

	MULTIPLE TR	UCK LOADING	SINGLE TRUC	K LOADING
STRUCTURE	W/IMPACT	LOW IMPACT	W/IMPACT	LOW IMPACT
ID	RATING SAFE FACTOR LOAD (TONS)	RATING SAFE FACTOR LOAD (TONS)	RATING SAFE FACTOR LOAD (TONS)	RATING SAFE FACTOR LOAD (TONS)
S080_41204L S080_41465L S080_40977L S080_40797L S080_40797L S080_40872L	1.21 90.53 1.52 113.99 0.98 73.51 0.91 68.49 1.17 87.88	1.75 130.90 1.08 81.35 1.01 75.80 1.38 103.85	1.93 145.08 1.24 93.55 1.16 87.17 1.17 87.88	2.22 166.60 1.38 103.54 1.28 96.47 1.38 103.85
S080_40927L S080_40577L S080_40375L S080_40414L S080_40429L S080_39904L	1.19 89.36 1.01 75.54 1.53 114.84 1.02 76.18 0.87 65.10 1.07 80.03	1.19 89.27 1.70 127.60 1.19 89.28 1.03 76.94	1.28 96.14 1.94 146.16 1.29 96.96 1.10 82.86	1.51 113.61 2.16 162.40 1.51 113.62

Command Output

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HIGHLIGHT BREDGE(S) ON LIN





Live Load Analysis Process Revisited...

- Every bridge along the route ...
- For <u>every member</u> in each bridge <u>check every</u> <u>1/10 point in each span</u>
- Perform moment, shear and serviceability rating for the permit vehicle
- Determine critical rating
- Perform each rating considering multiple lane full and low impact and single lane full and low impact
- Optionally generate restrictions based on the rating result

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Demonstration: Automated Permitting

Official Nebraska Government Website

			raska Department of Ro Truck Permit Sys		
ermits Home	FAQ	Login to Existing Account	Create New User Profile	Contact Permits Office	
		System Me	ssage		
Go	directly to the su	Subscribe Subscribe NOW Ibscription area and sign up for automatic IDOR whenever this page is updated	or, <u>Find out MOR</u> (Before you Subscrib about the NEW Service that lets automatic updates from N	e) s you receive	Permit Administratior
	System Messages Check the NDOR Flood Info Page for updated news on 2011 Flood Detours Nebraska State Government offices will be CLOSED Monday, Sept. 5, 2011, in observance of Labor Day Hay Haulers Info on Movement of Hay in Nebraska Thank you for using the NATPS. Please check our Info Links below or contact our offices during regular business hours, 8a-5p Central Time, if you have questions				Routing
					Bridge Analysis
	We've got a NEW "handle" - It's easy to remember! http://www.truckpermits.nebraska.gov			r!	Restriction Managemer
7	he informatio	Lost your User Name or Pa n will be e-mailed to you during our	assword? Click HERE	Central Time	

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Summary

- NDOR processes approx. 107,000 permits a year
- Of this total, approximately 75 80% are self issued (i.e. no human intervention)
- Of the self issued permits, approx 33% or 26,300 are self issue permits that require weight analysis.
- At \$25 per permit, this represents \$658,000 in annual revenue for OW or OS/OW permits that require no manual intervention



In Conclusion

- Bridge analysis typically is the log jam in the OS/OW permit issuance process
- The quicker the bridges are analyzed (rated) the quicker the permit is issued
- Without load rating, automatic permit self issuance would be very difficult if not impossible to achieve
- A rigorous verification process is important
- Bridge analysis to support OS/OW permit analysis can be done semi-automated or fully automated with beneficial results.



Benefits

- Analyzing every bridge every time a permit is issued leaves nothing to chance and helps preserve infrastructure
- Automation facilitates/increases permit revenue
- Automation reduces labor needed to issue a permit
- Especially in the bridge group, routine permits are handled by the system freeing engineer time for detailed issues

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Questions? ********* SIZE LOAD

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Thank You!

