In-Depth Timber Bridge Inspection And Load Rating

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Overview

- Introduction
- Why Do We Inspect and Load Rate Bridges in The United States?
- Bridge Inspection Types
- Bridge Inspection Procedures
- Load Rating
- Conclusion

Introduction

- FS has **3,450** Road bridges
  - Timber superstructures
  - Steel stringers with timber decks
- FS is the #1 federal agency with timber bridges

Why Do We Inspect and Load Rate Bridges in The United States?

- It is the Law – Title 23, Part 650 (23 CFR 650) – Bridges, Structures, and Hydraulics
- Inspection – Maximum of every 24 months
- Load Rating – Safe load-carrying capacity
- AASHTO's *The Manual for Bridge Evaluation*

Bridge Inspection Types

- Types of inspections
  - Visual
  - In-Depth Inspections

Visual Inspections

- Most common method of inspection
- Use human senses
  - Vision, touch, hearing, and smell
- Non-specialized equipment

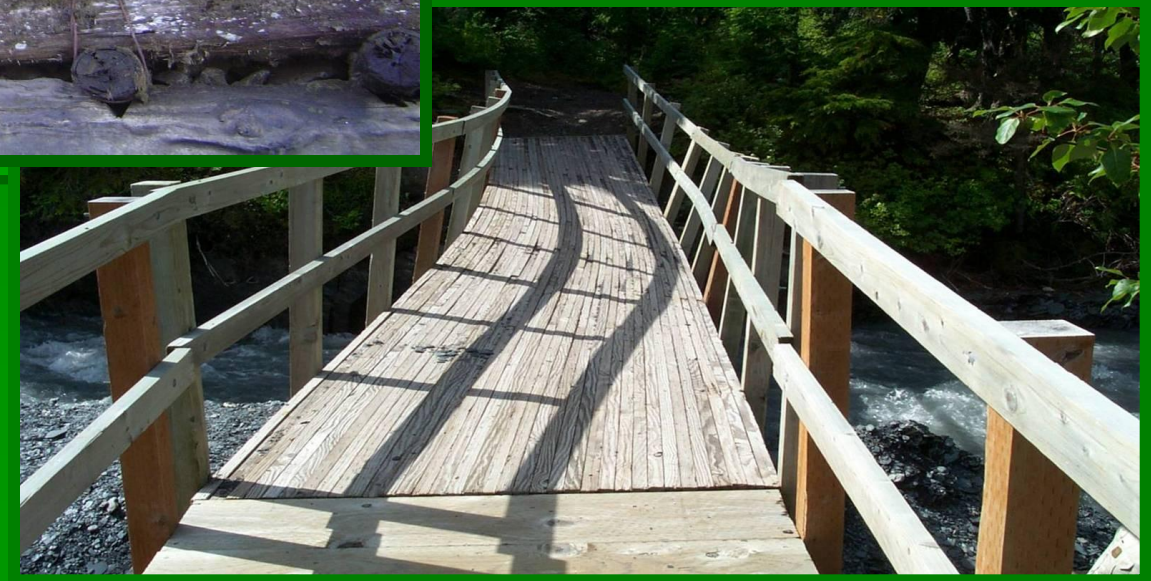
Visual inspections

- Two categories
  - Cursory
  - Hands-on

Cursory inspections

- Looking at the bridge as a whole
- Identifying possible defects or problems
  - Sagging beams
  - Water ponding
  - Uneven surfaces
  - Other things

Cursory Inspections



Hands-on Inspection

- Get within an arm's reach
- Defects are identified visually
- Physical procedures used to find out the extent of the deterioration or decay
- The basic methods for physical examination are:
  - Sounding - Hammer
  - Pick Test - Awl

Sounding

Interpreting Soundings:

- Sound timber gives a crisp sound.
- Defective timber gives a dull sound.
- Loose hardware will vibrate.

Note: A 2 inch thick shell of competent wood is sufficient to mask any interior rot.

Pick Test

- Probing with a pointed tool such as an awl will locate decay near the wood surface.
- Decay will be evidenced by excessive softness or lack of resistance to the probe penetration and the breakage pattern of the splinters.
- A brash break indicates decayed wood, whereas a crisp splintered break with the splinter hinging from one end indicates sound wood.

Pick Test

Decayed wood breaks abruptly across grain without splintering.

Sound wood pries out as long splinters.

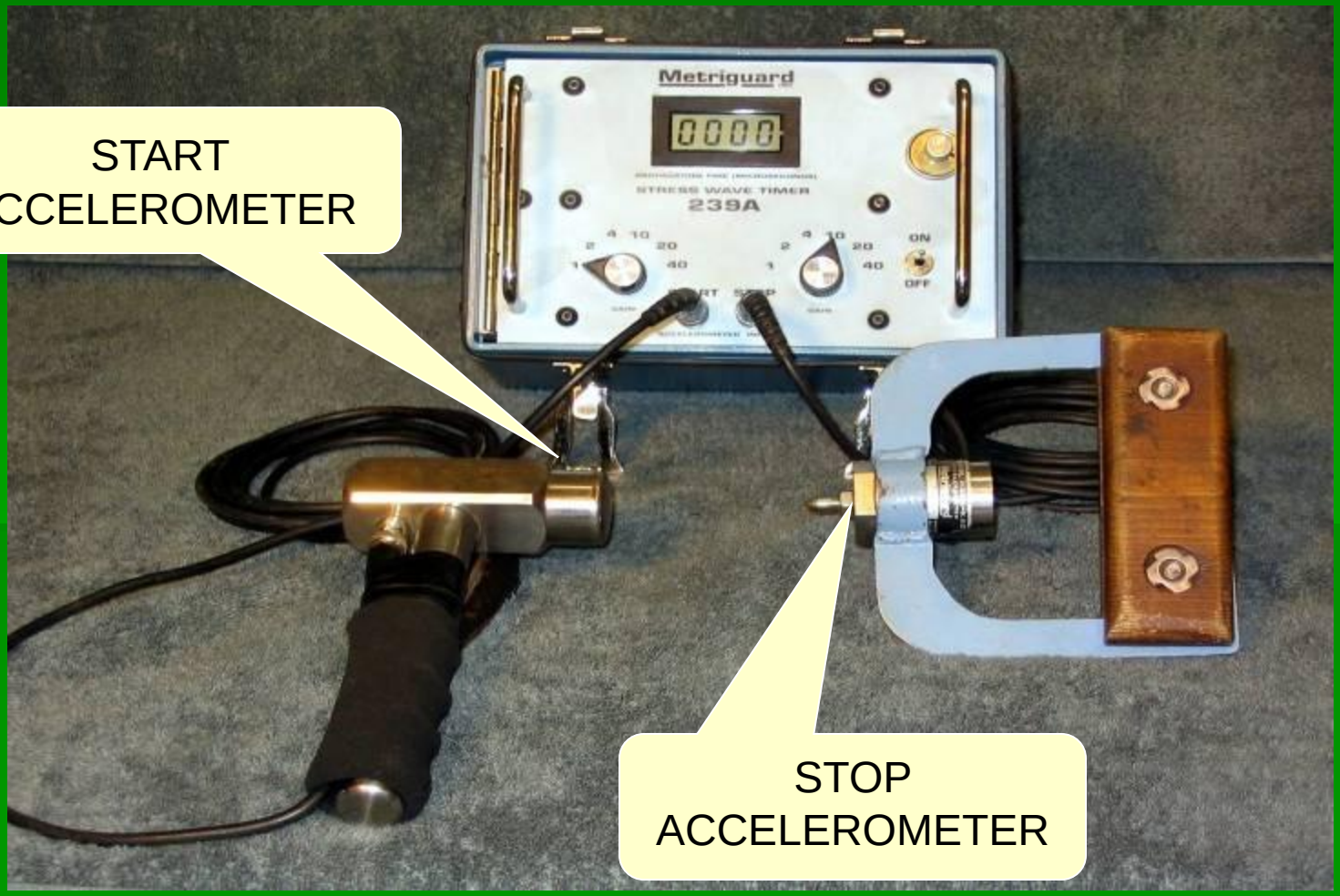
In-Depth Inspections

- Non-Destructive Testing
- Use specific equipment for type of material
  - Moisture Meter
  - Stress Wave Tester
  - Resistograph

Moisture Meter

- Measure the percentage of water
- Decay may be present when the moisture content exceeds 25 percent

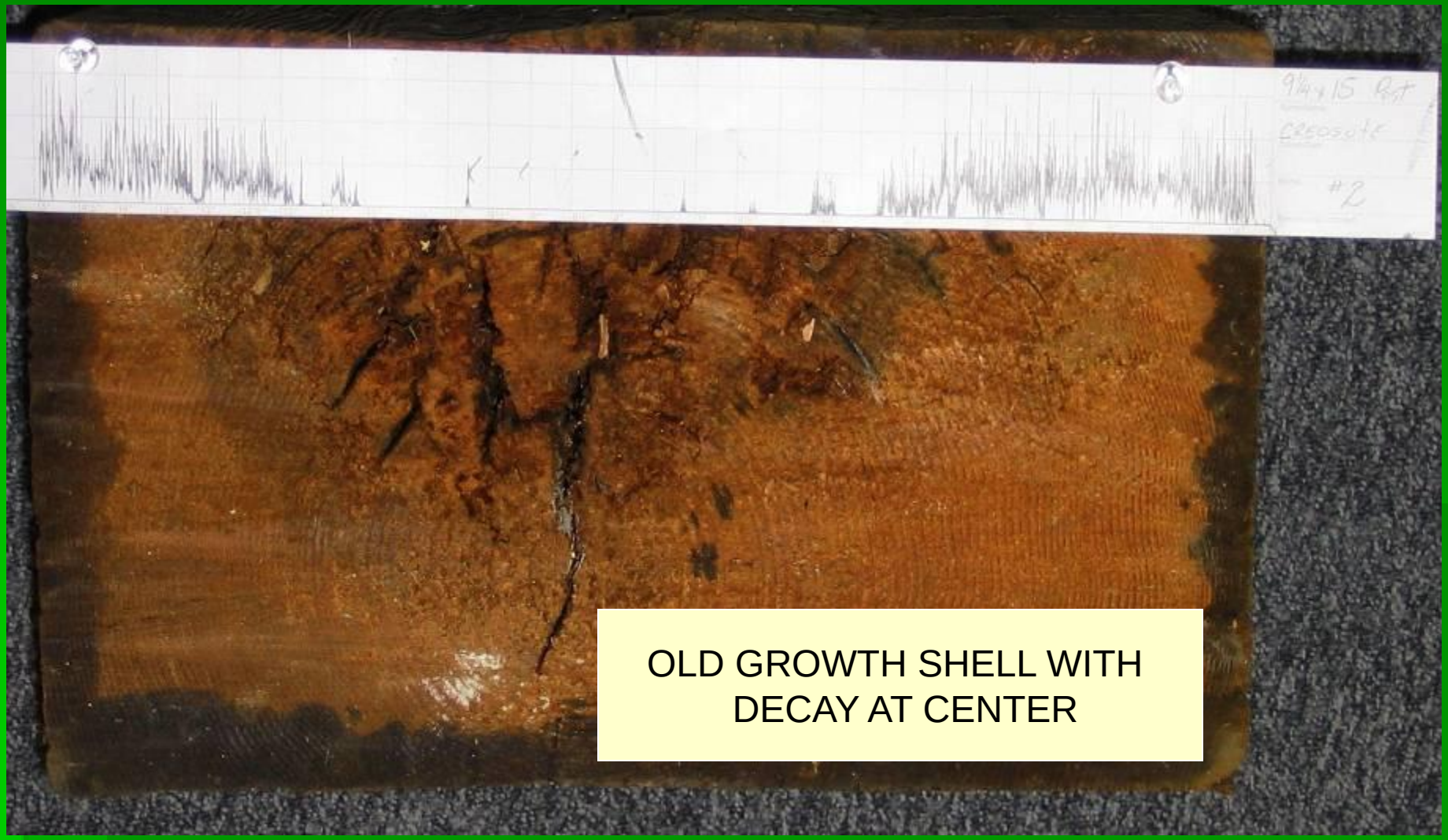
METRIGUARD 239A STRESS WAVE TIMER



RESISTOGRAPH DRILL

- NON DESTRUCTIVE TESTING OF WOOD BRIDGE MEMBERS
- DATA OUTPUT
  A) PAPER COPY
  B) DIGITAL FILE

Example Output



Bridge Inspection Procedures

- Conduct a cursory inspection
- Conduct a hands-on inspection
- Conduct an in-depth inspection
  - Take moisture readings at areas of dampness, crushing, or any other signs of distress
  - Take stress wave readings along the entire length of the beam and marking high reading locations with chalk
  - Drill location high stress wave reading locations with the resistograph
  - Draw up a diagram of all problem locations

Bridge Inspection Procedures

- Collect data required for load rating:
  - Total deck width and clear travel width
  - Species and grade of beams and decking
  - Beam type, size, and spacing
  - Span length and bracing locations
  - Deck type and size
  - Moisture content of beams and decking
  - Section loss of beams and decking

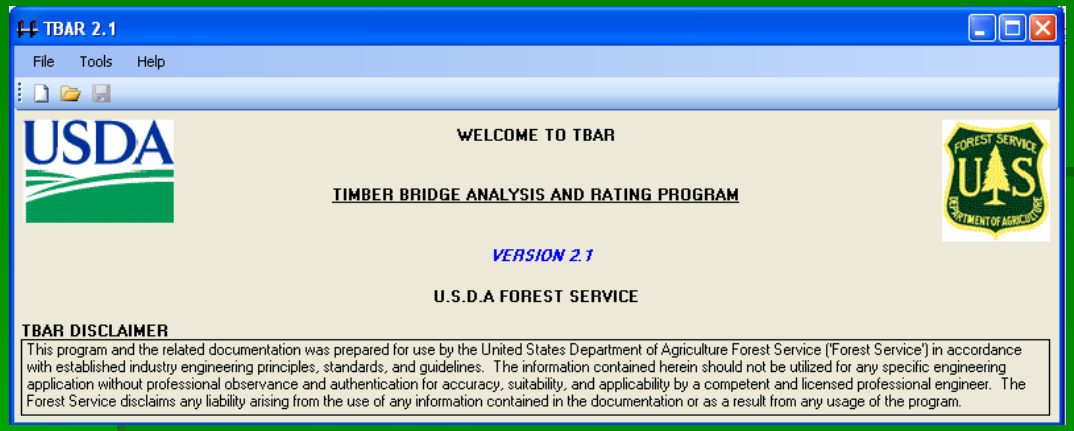
Load Rating

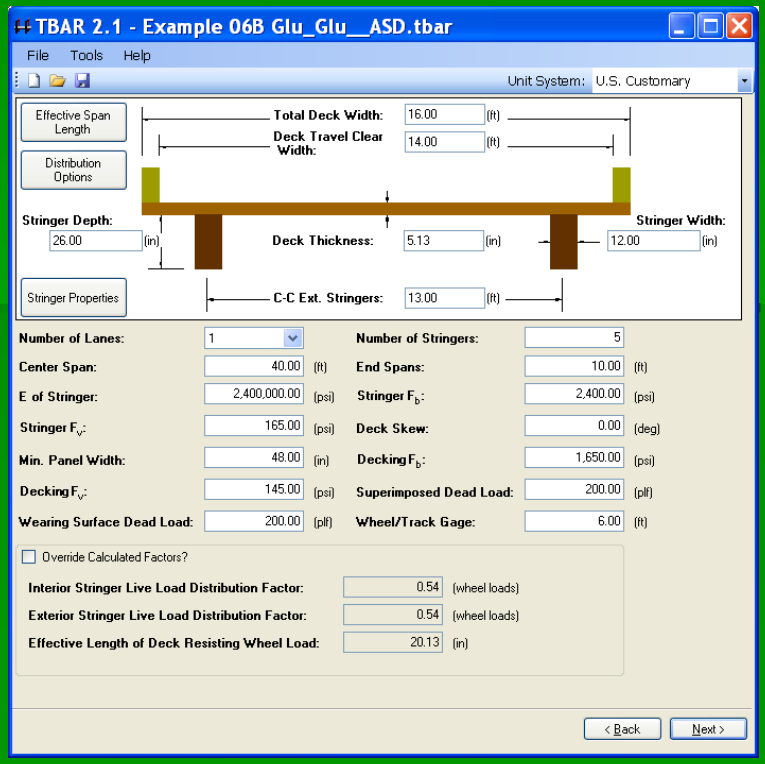
- Forest Service uses two programs to load rate timber bridges
  - Timber Bridge Analysis and Rating (TBAR)
  - MathCad

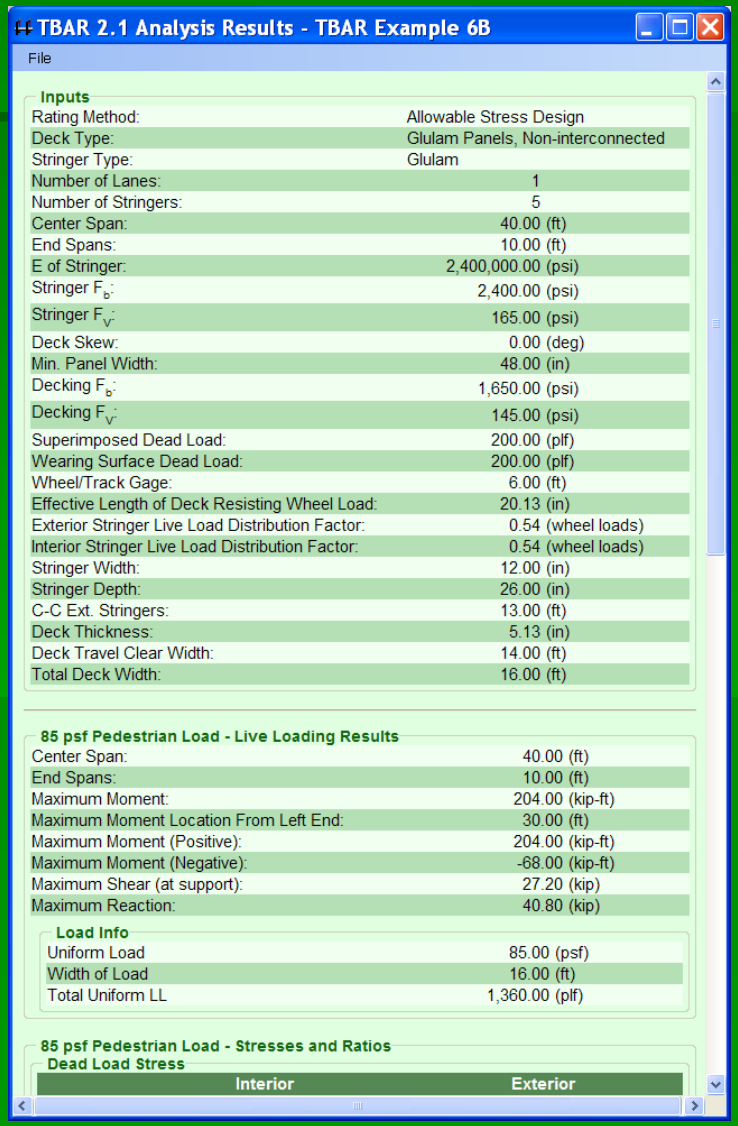
TBAR – Version 2.1

- Developed for the Forest Service by HDR Engineering, Inc, through an A&E Service Contract
- Two earlier DOS programs
  - TBSR (R1 and R6)
  - Timber Bridge Rating Program (R4)
- In 2009, Revised and Enhanced

TBAR – Version 2.1







TBAR Capabilities

- Simple Span or 3-Span with Cantilevered Ends
- Rating Methods - ASD or LRFD
- Units - U.S. Customary (English) or Metric

Bridge Types

- Stringer Types
  - Timber girders
    - Solid sawn
    - Glued-laminated
    - Logs
  - Steel girders
    - Standard sections or the properties may be input.

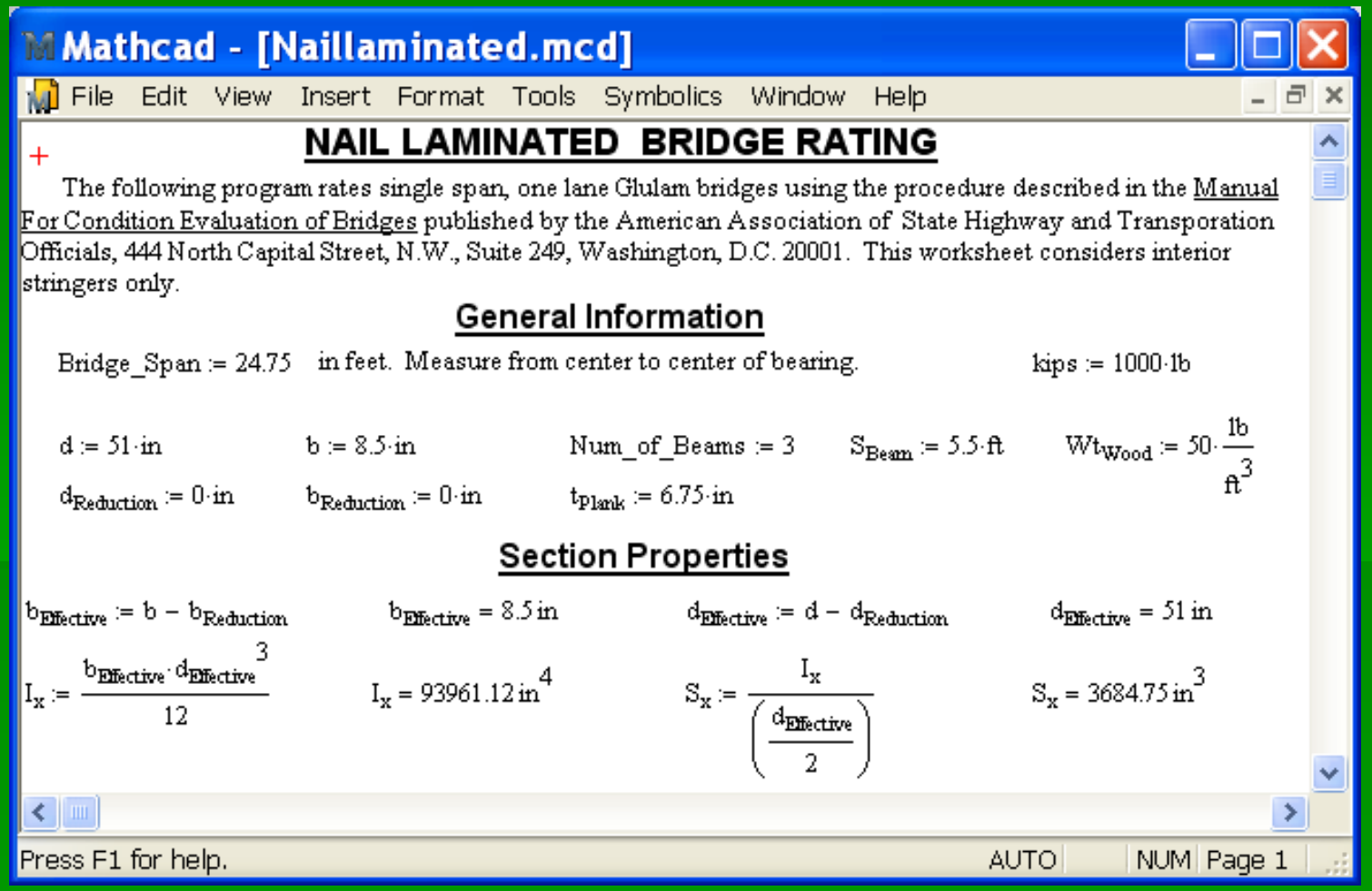
Bridge Types

- Timber Slab Bridges
  - Longitudinal glued-laminated deck panels
  - Longitudinal nail-laminated deck
  - Longitudinal spike-laminated deck

Bridge Types

- Deck Types
  - Solid sawn planks
  - Non-interconnected glued-laminated panels
  - Interconnected glued-laminated panels
  - Nail-laminated decks

Mathcad


Mathcad - [Naillaminated.mcd]
File Edit View Insert Format Tools Symbolics Window Help
NAIL LAMINATED BRIDGE RATING
The following program rates single span, one lane Glulam bridges using the procedure described in the Manual For Condition Evaluation of Bridges published by the American Association of State Highway and Transporation Officials, 444 North Capital Street, N.W., Suite 249, Washington, D.C. 20001. This worksheet considers interior stringers only.
General Information
Bridge_Span := 24.75 in feet. Measure from center to center of bearing.
kips := 1000·lb
d := 51·in
b := 8.5·in
Num_of_Beams := 3
S_Beam := 5.5·ft
Wt_Wood := 50·lb/ft^3
d_Reduction := 0·in
b_Reduction := 0·in
t_Plank := 6.75·in
Section Properties
b_Effective := b − b_Reduction
b_Effective = 8.5 in
d_Effective := d − d_Reduction
d_Effective = 51 in
I_x := b_Effective·d_Effective^3/12
I_x = 93961.12 in^4
S_x := I_x/(d_Effective/2)
S_x = 3684.75 in^3
Press F1 for help.
AUTO
NUM
Page 1

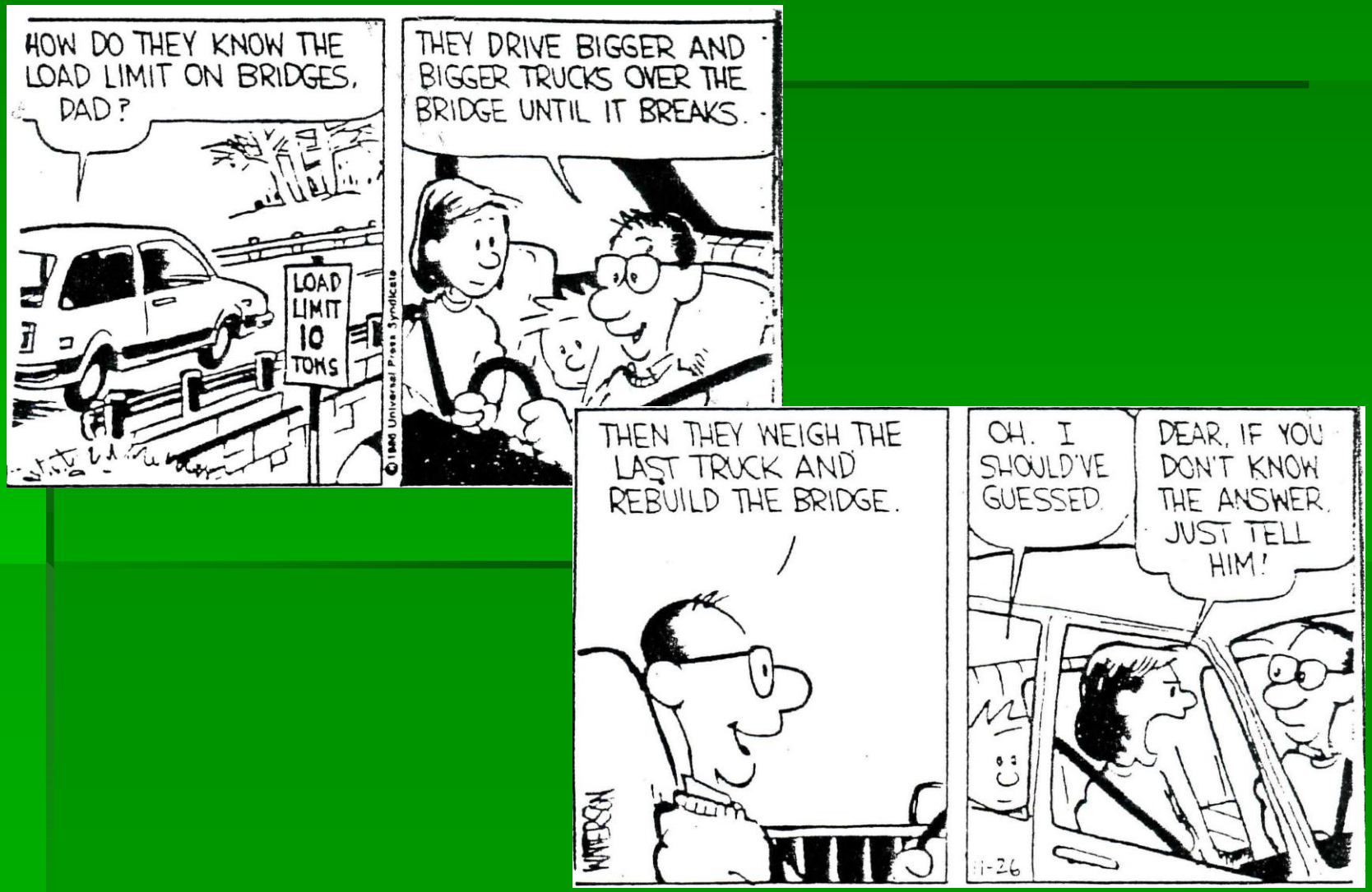
Conclusion

- A good inspection and load rating program will help to ensure that bridges are safe for use.
- Using specialized inspection equipment for in-depth evaluation of timber bridges provides the necessary information needed to load rate these bridges.
- TBAR is available for use outside of the Forest Service.

References

- AASHTO. *The Manual for Bridge Evaluation*
- FPL-GTR-6. *Electric Moisture Meters for Wood*
- FPL-GTR-160. *Condition Assessment of Timber Bridges 2. Evaluation of Several Stress-Wave Tools*
- FPL-GTR-159. *Condition Assessment of Timber Bridges 1. Evaluation of a Micro-Drilling Resistance Tool*
- HDR Engineering. USDA *Forest Service TBAR User Manual, Version 2.1*

Questions?


HOW DO THEY KNOW THE LOAD LIMIT ON BRIDGES, DAD?
LOAD LIMIT 10 TONS
THEY DRIVE BIGGER AND BIGGER TRUCKS OVER THE BRIDGE UNTIL IT BREAKS.
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THEN THEY WEIGH THE LAST TRUCK AND REBUILD THE BRIDGE.
WATTERSON
OH. I SHOULD'VE GUESSED.
DEAR, IF YOU DON'T KNOW THE ANSWER, JUST TELL HIM!
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