Load & Resistance Factor Design

New Bridge Design Method
Load & Resistance Factor Design

Session Topics

- Brief History
- What is LRFD?
- Why LRFD?
- When?
- How?
- What to expect?
Brief History
AASHTO Subcommittee on Bridges

In 1986 ~

- Committee concluded:
  - Standard Spec. had inconsistencies & gaps
  - Standard Spec. not up-to-date with emerging technology
  - Development of new specifications was warranted
Brief History

New Specification Objectives

- State-of-the-Art
- Comprehensive
- Consistent with itself
- Specification-like (rather than textbook-like)
- Multi-disciplinary in its approach to design
- Recognize importance of redundancy and ductility

AASTHO released 1\textsuperscript{st} Edition of Specification in 1994.
What is LRFD?
Philosophical Design Methods

Working Stress Method: $Q < NR$

- All applied loads assumed to have same degree of uncertainty.
  - Live & Dead loads are equally known
- Calculated resistance was not statistically based.
What is LRFD?

Philosophical Design Methods

Load Factor Method: \( \beta Q < NR \)

- Factors applied to loads and structural resistances to account for variable levels of uncertainty.
  - LL factors different than DL factors
- Calculated load & resistance were not statistically based.
What is LRFD?
Philosophical Design Methods

LRFD Method: \( Q < NR \)

- Factors applied to loads and structural resistances to account for variable levels of uncertainty.
- Load & resistance factors based on statistical probabilities.
Why LRFD?
Design Consistency

Standard Specification Reliability Index

Reliability Index

Span Length (ft)
Why LRFD?
Design Consistency

LRFD Reliability Index

Span Length (ft)

Reliability Index
Why LRFD?

AASHTO Specifications

- Only the AASHTO LRFD Bridge Design Specifications are currently maintained.
Why LRFD?

FHWA Mandate

“All new bridges on which States initiate preliminary engineering after October 1, 2007, shall be designed by the LRFD Specifications”

— David H. Densmore, FHWA, June 28, 2000

Failure to comply may jeopardize federal funding.
Projects beginning the following PDP steps after July 20, 2007:

- Major Projects – Step 6
- Minor Projects – Step 3
- Minimal Projects – Step 1

These steps are when the vertical profiles are established for the project.
Projects beginning the following PDP steps after October 1, 2007:

- Major Projects – Step 6
- Minor Projects – Step 3
- Minimal Projects – Step 1

These steps are when the vertical profiles are established for the project.
Federally Funded Projects not following ODOT PDP must use LRFD Specifications if preliminary design is started after Oct. 1, 2007.

Preliminary design is defined for this purpose as when vertical profile is established.
How?
Implementation Core Group

Group Priorities:
1. Study LRFD
2. Identify impacts to current ODOT publications
3. Develop LRFD-compliant policies
4. Develop training program
5. Develop design guidance
6. Provide support
How?

Implementation Core Group

Priority #1 – Study LRFD

- Read LRFD Specification
- Attend LRFD training
- Review LRFD design examples
- Perform comparison studies
- Keep abreast of interim revisions
How?
Implementation Core Group

Priority #2: Identify publication impacts
- Bridge Design Manual
- CMS, SS’s, & PN’s
- Standard Drawings
- Design Data Sheets
Priority #3: Develop LRFD policies

- Revise:
  - BDM
  - CMS, SS’s & PN’s

- Complete by July 2007 to meet implementation deadline.
How?

Implementation Core Group

Priority #4: Develop training program

- Provide training to:
  - ODOT staff
  - Local Public Agencies
  - Consultants

- Complete by July 2007 to meet implementation deadline.
Priority #5: Develop design guidance

- Revise:
  - Standard Drawings
  - Design Data Sheets

- Develop design aids

- To be initiated after Priority #3 completed
How?
Implementation Core Group

Priority #6: Provide Support

- Evaluate continuing LRFD training program
- Provide list of technical contacts
- On-line support (e.g. FAQ’s)
How?
Training

- University of Cincinnati, Ohio University, & University of Akron are developing training courses for ODOT.
- No fee for attendance.
- Courses will be offered: September 2006 – July 2007
- Each course will be 3 days long.
How?

Training

Four Separate Courses:

- Loads, Load Combinations & Prestressed Concrete Design
- Reinforced Concrete Design
- Steel Design
- Foundation Design
How?
Training

Each course will be offered at five regional locations:

- Columbus
- Greater Cleveland
- Greater Cincinnati
- Toledo
- Marietta
How?

Training

Course announcements will be made on the Office of Structural Engineering website:

http://www.dot.state.oh.us/se/
What to expect?

Learning Curve

- New language
  (Limit States, Load multipliers, Dynamic Load Allowance, HL-93, etc.)
- New analysis methods
- Computationally Intensive
- New software
- Others
What to expect?
Major Updates

- “State of the Art” changes to:
  - Concrete design
  - Steel design
  - Foundation design

- Independent of LRFD philosophy
  (All AASHTO updates appear in LRFD not Standard Specification)
What to expect?

AASHTO LRFD Commentary

Each article in the LRFD specification has a parallel commentary on the same page.
What to expect?

BDM Revisions

- Section 1000
  ODOT LRFD Bridge Design Specifications
  - References parallel AASHTO LRFD
  - Details provisions where ODOT and AASHTO LRFD do not concur
  - Provides commentary for ODOT’s interpretation of AASHTO LRFD provisions
  - Provides ODOT’s preferences on optional AASHTO LRFD provisions
- Rehabilitation designs using LRFD specifications
What to expect?
LRFD Live Load Model – HL-93

- Truck load and lane load applied simultaneously.
- More accurately represents fleet of permitted vehicles allowed on U.S. highways.
- After all applied load and distribution factors, LRFD design load for superstructures similar to 17th Edition using HS25 design loading.
What to expect?

Live Load Distribution

- More accurate than 17th Edition
- More complex than 17th Edition
- Increased design load for fascia girders
What to expect?

Live Load Impact

- New name “Dynamic Load Allowance”
- Constant 33% for design
What to expect?
Unified Concrete Design

- Reinforced concrete and prestressed concrete have been combined into one specification.
What to expect?
New Deck Slab Design Methods

Two Methods:

- **Equivalent Strip Method**
  Requires the deck to be analyzed as a continuous beam.

- **Empirical Design Method**
  The Department will not allow this method of analysis.
What to expect?

Curved Girder Design

- The steel structures section now covers the design of horizontally curved beam and girder structures.
What to expect?

Increased Foundation Costs

- Resistance factor bias
  Historically, ODOT’s confidence with driven piling has been higher than that reflected by LRFD resistance factors for driven piling.

- For pile supported foundations:
  - More piles
  - Longer estimated lengths