Load Rating For Deterioration

- Buried Structure Rating Criteria
  - LRFD 12.5 – Limit States and Resistance Factors
    - Metal Structures
    - Concrete Structures
    - Thermoplastic Pipe
    - Tunnel Liner Plate
    - Fiberglass Pipe
    - Steel-Reinforced Thermoplastic Pipe
Buried Structure Rating Criteria

MBE 6A.5.12.2

Flexure, Shear, and Thrust

6A.5.12.2—General Rating Requirements

Culvert ratings should recognize that these structures experience several loadings that are not applicable to most bridge superstructures, including vertical and horizontal soil loads and live load surcharge. Culvert structural members shall be evaluated for flexure, shear, and axial thrust. Load ratings at several critical sections for the culvert structure must be calculated for each load effect in order to establish the lowest load rating. Water load on interior walls may be neglected in load rating calculations.
Load Rating For Deterioration

- **INDOT Buried Structure Rating Process**
  - Flat Top
    - BrR – Vertical Loads (i.e. Soil arching is neglected)
  - Arch Top
    - Develop Loads: MathCAD
    - Analyze Structure: CANDE
    - Load Rate: Excel Spreadsheet
Load Rating For Deterioration

- Buried Structure Rating
  - Example Buried Concrete Arch Structure
Load Rating For Deterioration

- Buried Structure Rating
  - Model Geometric Coordinates
Load Rating For Deterioration

- Buried Structure Rating
  - CANDE Model Elements
Load Rating For Deterioration

- Buried Structure Rating
  - CANDE Model Elements
Load Rating For Deterioration

- Buried Structure Rating
  - Example Flat Top Structure – Showing Live Load Effects
Load Rating For Deterioration

MBE Compressive Element Load Rating

APPENDIX G6A—RATING OF CONCRETE COMPONENTS FOR COMPRESSION PLUS BENDING

Steps for Obtaining Rating Factors (see Figure G6A-1)

1. Develop the interaction diagram, by computer or manual methods, using as-inspected section properties.
2. Point A represents the factored dead load moment and thrust.
3. Using the factored live load moment and thrust for the rating live load, compute the live load eccentricity ($e_i = M_{el}/P_{el}$).
4. Continue from Point A with the live load eccentricity to the intersection with the interaction diagram.
5. Read the ultimate moment and axial capacities from the diagram.

6. Moment $RF = \frac{Moment \: Capacity \: - \: Factored \: M_{EL}}{Factored \: M_{EL,UL}}$

Axial $RF = \frac{Axial \: Capacity \: - \: Factored \: P_{EL}}{Factored \: P_{EL,UL}}$

Figure G6A-1—Axial Plus Bending Interaction Diagram for Concrete Structures
Load Rating For Deterioration

- Buried Structure Rating
  - Final Result: Rating Factors at Arch Nodal Coordinates For:
    - Shear
    - Combined Moment and Axial Force (P-M Analysis)
Load Rating For Deterioration

- Buried Structure Rating
  - Research:
    - JTRP SPR-3816: Steel Multi-Plate Arch
      - Wall Area Yielding
      - Buckling Strength
      - Seam Resistance