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Tapered Roller Bearing Test Rig: Axially Loaded Application to Accelerate Bearing Failure

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MECHANICAL AND NUCLEAR

Tapered Roller Bearing Test Rig

Axially Loaded Application to Accelerate Bearing Failure

CAPSTONE DESIGN EXPO 2015

Current Testing Method

Railcar Tapered Roller Bearings Manufactured by:

Amsted Rail

Fig 1: Railcar bearing

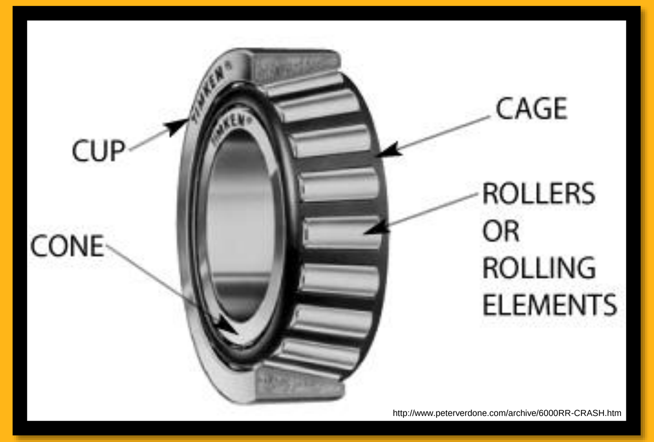

Fig 2: Conventional cup/cone tapered roller bearing diagram

- ❖ Other companies have the ability to test small scale bearings (with reduced fatigue life) using a multitude of test rigs to obtain failure data. Amsted Rail however, desires to have a new type of testing method to analyze larger bearings and to produce failure in a short amount of time.

Applied Load:

- ❖ Within current test rigs, forces are applied radially simulating actual railcar loading
- ❖ Currently a time frame of six to twelve months is required to obtain meaningful results

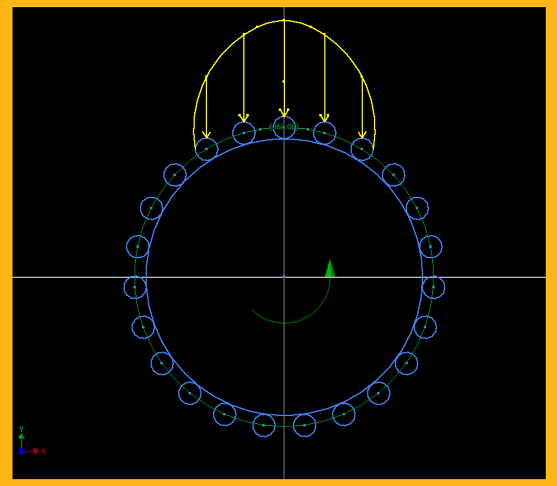

Fig 3: Load distribution using conventional testing method

Proposed Testing Method

Project Goal:

- ❖ To design an accelerated fatigue life test rig that will study Association of American Railroad Class K, 6 ½ x 9 inch double row tapered roller bearings by applying an axial load instead of the conventional radial load

Applied Load:

- ❖ Axially applied loads cause failure to occur at a more rapid pace in Class K bearings due to characteristic simultaneous loading on each roller while in motion (depicted in Fig. 4)

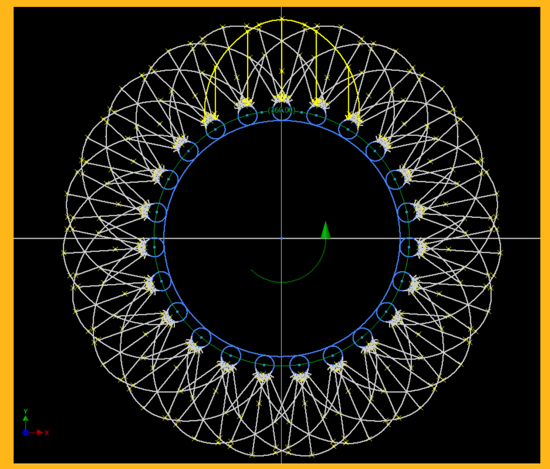

Fig 4: New loading distribution- axially loaded

Components:

1. **Electric Motor** – rotates the main driven cone shaft via a gear box
2. **Main Driven Cone Shaft** – rotates press-fitted cone assembly and secondary cone spline shaft
3. **Cone Assembly** – rotates inside of the static cup
4. **Cup** – supported, cooled, and held statically by the split pillow block
5. **Secondary Cone Spline Shaft** – rotates secondary cone assembly inside of cup
6. **Hydraulic Piston** – supports secondary cone spline shaft and applies load (19,942 lb_f) from hydraulic cylinder via slip-fitted thrust bearings

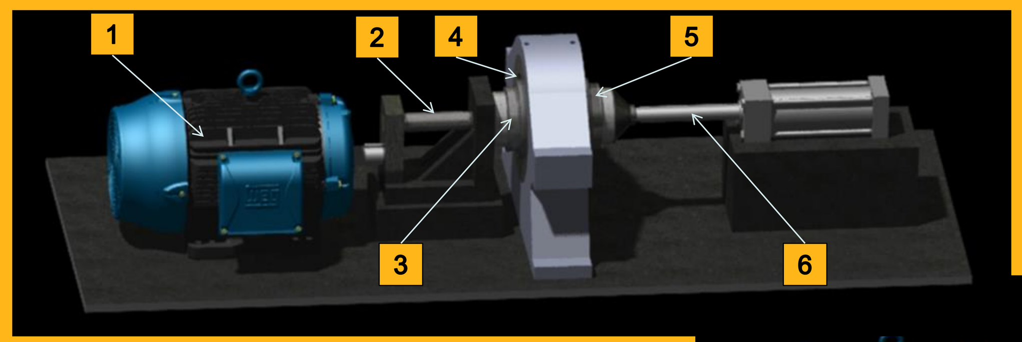

Fig 5: Extended (Running) Position

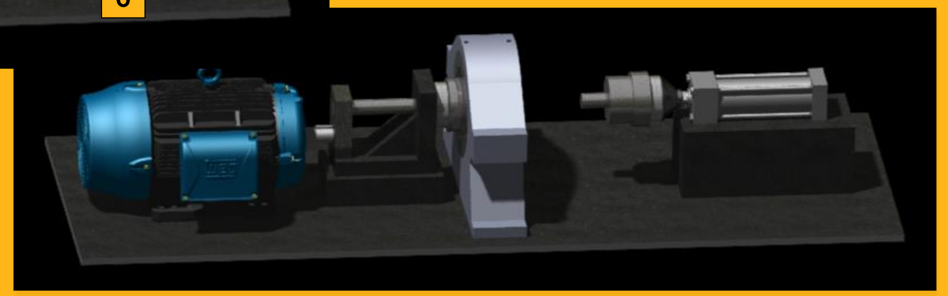

Fig 6: Retracted (Disassembly) Position

Specifications and Results

Testing Method Specifications

- ❖ **Bearing Specifications:**
  - ➢ 23 rollers per row ⟶ 46 total rollers
  - ➢ Class K
  - ➢ 6 ½ x 9 inch
  - ➢ Double row
  - ➢ Tapered
- ❖ **Axial Load Required:**
  - ➢ Total Load required by Piston: 19,941.9 lb_f
  - ➢ Ram Selection: 30,000 lb_f to allow for increased loading in future applications
- ❖ **Heat Generated:**
  - ➢ Per roller = 22.12 BTU/min
  - ➢ Total = 1017.4 BTU/min
- ❖ **Torque Required:**
  - ➢ 43.99 lb_f-in. per roller
  - ➢ 2023.76 lb_f-in total = 168.65 lb_f-ft
- ❖ **Motor HP:**
  - ➢ Total Required: 23.99 HP
  - ➢ Motor Selection: 40 HP to allow for increased loading in future applications
- ❖ **Cooling Method:**
  - ➢ Custom designed oil cooled jacket to allow operating temperature to remain at or below 100 ˚F

Results:

- ❖ **L_{10} Rating:**
  - ➢ 14.75 million cycles
  - ➢ 1.1 months or 34.3 days