Loaded Car Hunting

Mechanical Association Railcar Technical Services

Loaded Car Hunting and Suspension Systems

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Loaded Car Hunting

Suspension, vehicle and track are a system
Demand for Productivity Increases

- Increased train velocity and improved asset utilization …
  - Longer trains
  - Heavier car loads
  - More lading per railcar / higher C.G, etc.

- Increased railcar sensitivity to …
  - Load balance and vehicle stability
  - Speed and track conditions
  - Car construction

= More demanding operating environment
Many Moving Parts - Wear and Tear

- System interaction impacts performance
  - Suspension and coupling systems
  - Freight car structure and body
  - Track systems and operations
- Desired component and system attributes
  - Quality / integrity / reliability
  - Reduced in-service failure and downtime
  - Long life / low maintenance / reduced wear

Operating environment is a complex system

- Safety / security / service reliability
- System capacity and efficiency
- Asset utilization
- Train velocity
- Productivity
Truck System Performance

More demanding environment

Truck system performance

AAR Specification M-976

Steering

Curve negotiation with minimal effect on high speed stability

Reduced wheel and track wear

Suspension

Damping of vertical and lateral inputs; truck squaring

Reduced impact of loading conditions
M-976 Performance Requirements

- **Tightened parameters** for heavier car loads
  - To be easier on track (and stay on track)
  - To reduce car inputs and component wear
- **Test regimes** (empty and loaded covered hoppers @ TTCI test track)
  - Hunting (loaded car hunting threshold being considered for M-976 re-write)
  - Steady state curving
  - Curve resistance
  - Spiral
  - Twist, roll
  - Pitch, bounce
  - Yaw, sway
  - Dynamic curving
Key Truck System Components

• Stability / hunting control
  – Squaring; dimension control; friction wedges
  – **Center bowl liner** (loaded car) – rotational resistance / friction damping (too low = stability issues)
  – **Side bearings** (light car) – rotational resistance / friction damping; railcar roll control

• **Reduced rolling resistance**
  (to reduce wheel tread wear and wheel flange wear)
  – Low torque bearings
  – Passive steering components
  – Round / consistent tape wheels
Passive Steering System

• Steering = axle movement to negotiate curves (axles move out of parallel)
• Elastomeric pad and special metal adapter enable steering (and absorb energy)
  – Pad deflects in shear with controlled stiffness (too stiff = harder on wheel; too soft = hunting / stability issues)
  – Stored pad energy restores axle on tangent track
  – Standard metal adapters can stick due to friction, causing wheel / flange scrubbing

• Curving vs. Stability…
  – Passive mechanical system is a compromise
  – Balance curving resistance and high speed stability

Reduces truck component loads and wear
Adapter Plus Bearing Adapter

- Protects pedestal roof and thrust lugs from wear
- Controlled resistance, tight fit (+ clearance => hunting)
- Improves Radial Wheelset Alignment
  - Improve Curving
  - Passive Steering
- Evenly distributes bearing load
  - Increase life of roller bearing
  - Reduce Rolling Resistance
- Attenuates vertical impacts
- Nearly 1.5 million in service globally
  - Excellent track record
  - Improve wheel wear (Brazil)
  - Reduce noise (Australia)
The Problem

• ~ 6,000 5,161 c.f. grain hopper cars built 2004 - 2006
  Grain export service to ports in Mexico
  No indication of pad degradation for 1 ½ - 2 years
  Center bowl liner low friction lowered hunting threshold
  Side bearing elements lost preload, reducing capacity to dampen hunting oscillations

• Several inputs simultaneously caused severe hunting
  – Combination of speed / track condition / loading condition can cause pad degradation as an isolated event
  – 10 percent of cars experienced problem
  – One pad affected; other seven were okay
**System Testing**

- **Field testing in revenue service**
  - Instrumented car in Granite City, IL
  - Started in November 2006
  - Loaded hunting evident during instrumented trips, 50 – 60 mph speed
  - New wheelsets – hunting eliminated; worn wheel profiles impact hunting modes
  - Imbalanced loading affects stability

- **Laboratory testing of pads**
  - Existing and new compounds / configurations
  - Using field test data, replicated pad degradation
  - Hysteretic heat generation at higher frequencies during severe hunting causes breakdown from inside out
Approaches to LCH problem

• **Attenuate the inputs** that are resulting in loaded car hunting
  - Track profile; track grinding practices
  - Track gauge; track maintenance
  - Worn wheel profile / maintenance
  - Control imbalanced loading
  - Overall vehicle stability; torsional stiffness
  - Suspension specific to vehicle and service type

• **Modify equipment** to mitigate the effect of the inputs
  - Suspension equipment modifications
  - Additional equipment – dampers, springs…
  - Car body modifications
  - Modified wheel profile
Motion Control ® Testing at TTCI

L1 Adapter Motions
Comparison of Standard Pads vs. Steel Adapter
55mph Loaded Car Hunting Speed

Lateral Displacement (in)

Longitudinal Displacement (in)

- Standard Pads
- Steel Adapter
Motion Control® Testing at TTCI

L1 Adapter Motions
Comparison of Rubber Pads vs. Steel Adapter
55mph Loaded Car Hunting Speed

- Lateral Displacement (in)
- Longitudinal Displacement (in)

- Dotted Line: Rubber Pads
- Solid Line: Steel Adapter
Motion Control® Testing at TTCI

L1 Adapter Motions
Comparison of Stiff Pads vs. Steel Adapter
55mph Loaded Car Hunting Speed
Motion Control ® Testing at TTCI
Findings

- Softer pad material = higher deflections
- **Stiffer** pad material = lower deflections
  - Less movement per pound of force
  - Less energy input - reduced hysteretic heating
  - Increase in hunting threshold
- **Metal** adapters in same car series and service showed uneven wheel / flange wear; M-976 trucks showed more even wear
- **Solution** = Stiffer pads with higher friction center bowl liners surviving in actual service; maintaining benefits of curving and even wear
- **Alternatives** exist to mitigate hunting and associated wheel tread scrubbing
What does this mean for maintenance?

- Heavier loads and longer trains = increased wear and tear
- Inspection is required to determine necessary repairs, and/or…
  - Wayside detector, TPD or WILD setouts
  - Scheduled (Preventive) maintenance
  - Reactive (Corrective) maintenance
  - Alternatives?
- Maintenance budgets are tight, but asset utilization and uptime are critical
## Maintenance Philosophy

### Preventive Maintenance
- **Scheduled** maintenance based on life statistics of similar equipment
- **High** maintenance costs - *unnecessary* maintenance
- **Low** operating costs – limited downtime scheduled

### Corrective Maintenance
- **Reactive** maintenance - run equipment to **failure**; *no* scheduled maintenance
- **Low** maintenance costs – performed only after **failure**
- **High** operating costs – downtime and damage

### Condition Based Maintenance
- Maintenance only *when required*
- Availability of the equipment is guaranteed
- Extends useful life of equipment
- *Unnecessary maintenance is avoided*
- *Overall cost* is reduced
- *Condition monitoring* adds cost

* Condition monitoring adds cost

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Condition Based Maintenance (CBM)

- Preventive maintenance may prevent some failures, but premature failures still occur.
- **Corrective maintenance** promises lower costs, but cost of reaction to failures is high.
- Benefits of **CBM strategy**
  - Lower operating costs
  - Extend useful life of equipment
  - Increase productivity and maximize asset uptime
  - Increase network velocity and reduce congestion
- Execute **CBM strategy**
  - Consider operating environment
  - Measure and analyze parameters real-time
  - Relay message to effect maintenance or repair (pre-emptively – *before* a failure occurs)
Fleet Maintenance with CBM

- A Condition Based Maintenance strategy should enable improved asset utilization and lower maintenance costs
- Knowledge of maintenance issues and volume will accelerate with CBM
- We can expect a better life cycle cost with CBM than is realized with current practices
- Diagnostic / prognostic technologies are progressing rapidly and becoming feasible and cost-effective