Heavy Hauling: A Worldwide Update and Highlights from IHHA2015

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Agenda

- A snapshot of the heaviest haulers
- One example: Daqin China
- One example: Fortescue Australia
- Heavy Haul Best Practice
- Technologies highlighted at IHHA2015
- Headwinds highlighted at IHHA2015
- Some conclusions from IHHA2015

Heavy Haul Long Trains And Axle Loads Worldwide

IHHA Member Country	Axle Load (tons)	Standard Train Length (cars)	Future standard train length (cars)/axle loads (tons)
USA and Canada	36	129-170 cars	39 tons, 190-250 cars
Australia (Pilbara iron ore)			
• BHPBilliton • Rio Tinto • FMG	41 40 44	204 cars 236 240	333 cars Going to 50 ton axle loads
South Africa • Iron ore • Coal	 33 29	 216 cars 200	342 cars
Brazil • Vale iron ore	 36	 330 cars	42 tons
China • Daqin • Shuohuang	 28 33	 210 cars	40 tons
Russia	20		33 tons
Sweden • LKAB Iron Ore	 30	 68 cars	36 tons going to 44 tons

China's Daqin Line

- 653 km electrified double track
- 375 million gross tons/year
- Mountainous terrain with many tunnels up to 5 mi. long
- Two 30mi. long grades in downward direction

Innovations for Chinese Heavy Haul

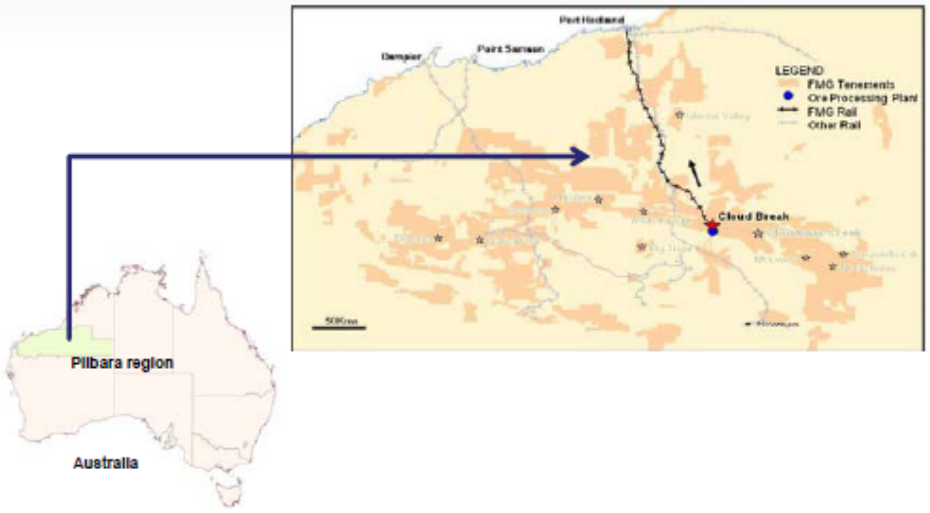
- 10,000 kW (13,400 HP) electric locos
- Elastic rubber drawgears to reduce longitudinal forces
- Locotrol with GSM-R integration, for locos in 3-4 positions in 22,000 ton trains
- ECP Braking
- Aluminum/SS carbody coal gons
- Gons permanently coupled in sets of 3 with rotary couplers

Mechanical Inspection of Trains

- Acoustic bearing detectors and hot wheel and bearing detectors
- Car inspectors review images gathered from 5 cameras
- Inbound train inspection time reduced from 1 hour to 14 minutes

Fortescue Railway

In the Pilbara



Track Construction

Achievements

- 288km of track constructed in < 9 months
- 35 mtpa rate operation within 12 months of start up
- Proved 40 tonne axle load operation
- Readily expandable to 200 mtpa

288km of track, 19,584 tonnes of rail, 427,000 sleepers and 7 million cubic metres of earth

Highlights

- Trains started running on 5 April 2008
- 1,100 trains delivering 26 million tonnes to date
- Driver only operations – 240 car trains
- Train control in Perth 1,600 km away
- 4 x 240 car train sets (55 mtpa)
- Cycle time <20 hours

Rollingstock

Basis of design

- Proven locomotives modified for Pilbara conditions
- Ore cars designed for 40 tonne axle load
- Ore car wheel improved AAR standard <1mm FBH defect allowed (Maanshan Iron & Steel)
- Ore car castings of higher quality and strength than AAR standards
- Wheel profile design specifically for Fortescue to match rail head profile
- Mainline train speed of 80 km/h loaded
- Ore cars married pair with single brake controller
- AAR plate "C" clearance outline
- ECP brake system (Knorr-Bremse)

Locomotives (manufactured by GE)

15 x 44CW GE Dash – 9 (4,400HP)

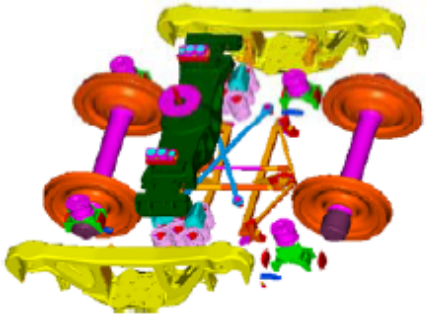
Ore cars (manufactured by CYR)

976 of the world's heaviest haul ore cars

Ore car workshop is highly automated

Ore car bogie

- Metalastic primary suspension
- Cross braced bogie (minimise wheel flange wear)
- Improved casting strength of bolsters and sideframes for 40 tonne axle load
- 2 stage secondary suspension for improved empty ride performance



Heavy Haul Best Practice

- 40,000t trains with distributed power in up to 4 locations
- Axle loads up to 44 tons
- ECP braking
- Single driver, with fuel and train dynamics analyzers
- Control devices for longitudinal forces
- Increased payload to tare ratios
- Wayside and onboard diagnostics

Heavy Haul Best Practice

- Managed friction
- Wheel/rail profile matching
- Micro-alloyed wheels and rails
- All welds are flash butt
- Concrete sleepers and reinforced concrete bridges
- Scheduled precision railroading
- Condition-based maintenance with wear and defect trending
- Bogie tracking diagnostics and 2 mm wheel tread hollow spec.

Technologies Highlighted at IHHA2015

- Phased array ultrasonic testing
- New models of stress analysis, dynamic simulation and fracture mechanics
- Expansion of automated asset health monitoring, and shift to condition based maintenance guided by rules engines and trending
- Continued growth in strength of materials through microalloying, lighter weight stainless steel in wagons

Technologies Highlighted at IHHA2015

- Evolution in the practice and use of ECP braking
- Elastic pads under concrete ties and turnouts
- Greater use and carry down of friction modifiers and further evidence they lower the stress state
- New designs of couplers, yokes and draft gear
- Green technologies for motive power
- Communication-based train control as a boost to network capacity
- The growth of autonomous instrumented freight cars doing frequent, performance-based track inspections

Headwinds Highlighted at IHHA2015

- The transformation to a rolling contact fatigue regime with increases in axle loads beyond 33 tonnes
- The onset of rail weld failures as rail lives continue to increase with better metallurgy and maintenance practices
- The high cost of operational variances like low train speeds of under-powered trains, tread hollowed wheels, bad actor cars, poor track drainage and high impact wheels

Some Conclusions from IHHA2015

- **No heavy haul railway has been successful without learning wheel/rail interface basics.**
- **Longer trains can be both more productive and less destructive.**
- **Heavier axle loads bring on a stress-based regime, but can be managed.**
- **Maintenance can be proactive and preventive**
- **ECP braking is here to stay and will only improve.**
- **There is much scope to support train drivers and inspectors with technology. Automation?**

See you in Cape Town!