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18th WCNDT

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World Conference on Non Destructive Testing
Non-Destructive Testing and Inspection of Rails at JSPL – Ensuring Safety and Reliability

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## Business segment

<table>
<thead>
<tr>
<th>Steel</th>
<th>Power</th>
<th>Mining</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Steel Image" /></td>
<td><img src="image2.png" alt="Power Image" /></td>
<td><img src="image3.png" alt="Mining Image" /></td>
</tr>
</tbody>
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Corporate snapshot

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- Steel: 3 MTPA
- Iron Ore & Coal Mining: 15 MTPA
- Power Generation: 1,783 MW
- Hot Briquetted Iron: 1.5 MTPA
- Pellet Plant: 5 MTPA
# Project – Under implementation

<table>
<thead>
<tr>
<th>Location</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angul, Orissa</td>
<td>1.6 MTPA Steel Plant</td>
</tr>
<tr>
<td></td>
<td>810 MW Captive power</td>
</tr>
<tr>
<td>Patratu, Jharkand</td>
<td>3 MTPA Steel Plant</td>
</tr>
<tr>
<td>Bolivia</td>
<td>1.7 MTPA Steel Plant</td>
</tr>
<tr>
<td>Orissa</td>
<td>80,000 BPD Coal to Liquid</td>
</tr>
<tr>
<td>Chhattisgarh</td>
<td>2, 400 MW Thermal Power,</td>
</tr>
<tr>
<td>Jharkand</td>
<td>1, 980 MW Thermal Power</td>
</tr>
<tr>
<td>Arunachal Pradesh</td>
<td>6,100 MW Hydro Power</td>
</tr>
</tbody>
</table>
# Project – Under planning

<table>
<thead>
<tr>
<th>Location</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angul, Orissa</td>
<td>2.8 MTPA Steel Plant &amp; 6 MTPA Pellet Plant</td>
</tr>
<tr>
<td>Patratu, Jharkand</td>
<td>3 MTPA Steel Plant</td>
</tr>
<tr>
<td>Raigarh, Chhatisgarh</td>
<td>3 MTPA Steel Plant</td>
</tr>
<tr>
<td>Bolivia</td>
<td>5 MTPA Pellet Plant, 4 MTPA DRI</td>
</tr>
<tr>
<td>Jharkand</td>
<td>2, 640 MW Thermal Power</td>
</tr>
<tr>
<td>Orissa</td>
<td>1, 320 MW Thermal Power</td>
</tr>
</tbody>
</table>

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JSPL – A young and dynamic company

<table>
<thead>
<tr>
<th>Core operational capacities</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ore mine</td>
<td>3.00 MTPA</td>
</tr>
<tr>
<td>Coal mine</td>
<td>12.00 MTPA</td>
</tr>
<tr>
<td>Pellet Plant</td>
<td>5.0 MTPA</td>
</tr>
<tr>
<td>Sponge Iron (coal based)</td>
<td>1.37 MTPA</td>
</tr>
<tr>
<td>Sponge Iron (Gas based- Oman)</td>
<td>1.50 MTPA</td>
</tr>
<tr>
<td>Hot Metal (Pig Iron)</td>
<td>1.65 MTPA</td>
</tr>
<tr>
<td><strong>Total Steel</strong></td>
<td><strong>3.00 MTPA</strong></td>
</tr>
<tr>
<td>- Rails, Beams &amp; Structural</td>
<td>0.75 MTPA</td>
</tr>
<tr>
<td>- Plates &amp; Coils</td>
<td>1.00 MTPA</td>
</tr>
<tr>
<td>- Medium Section Mill</td>
<td>0.60 MTPA</td>
</tr>
<tr>
<td>- Slabs, Rounds, Blooms &amp; Billets, Wire Rods</td>
<td>0.65 MTPA</td>
</tr>
<tr>
<td><strong>Total Captive Power Plant</strong></td>
<td><strong>759 MW</strong></td>
</tr>
<tr>
<td><strong>Wind Power</strong></td>
<td><strong>24 MW</strong></td>
</tr>
<tr>
<td><strong>Jindal Power Limited</strong></td>
<td><strong>1,000 MW</strong></td>
</tr>
</tbody>
</table>
Manufacturing facilities
The recently reconstructed Rail and Universal Beam Mill (RUBM) at the JSPL, is based on the most modern technologies available in the field of rolling.

It is possible to produce rails as finished products up to 121 metres long with very strict and uniform tolerances that satisfy all international standards and technical specifications. This guarantees maximum production flexibility and the satisfaction of the highest customer quality standards.
Rail & Universal Beam Mill

- 0.75 MTPA rolling capacity.
- Mill upgraded with a Universal Tandem Mill, latest technology in rolling of Structural sections and Rails.
- World’s longest Rail production facility to produce 121 Meter long rail.
- First in India to produce Large Parallel Flange Beams and Column sections. Beam sections up to 900 mm are in regular production as per BIS/Euro norms.
- Facility to produce 240/480 Meter Flash Butt Welded Rail panels.
Overview of the process route at RUBM

NDT Centre
Non-Destructive testing and inspection
**NDT & inspection - why**

- The challenge for rail manufacturers is to provide consistency in long, straight and flat rails, combined with dimensional accuracy and steel integrity to deliver defect-free rails with decades-long service life.

- This increasing requirement for products with fewer surface defects derives from a variety of different reasons such as: safety in use, operational reliability, extension of life cycle, travel comfort, track geometry, increased speed, increased axial loads, increased railway traffic.

- For the above mentioned reasons and for the many requirements of product quality control, the rails produced in the JSPL, are analysed in an integrated “system” of non-destructive testing and inspection.
NDT & inspection - Details

• Supplied and commissioned in 2003 by M/s Knorr Technik GmbH, Austria.

• System consists main five units.

1. Brushing machine
2. Flatness measuring Gauge
3. Eddy current tester
4. Ultrasonic tester
5. Paint marker

Final inspection (dimension, surface, etc.)
**Brushing unit**

- The main function of brushing machine is to descale the rail.

- The rails are online de-scaled by 4 pot brushes. The running surface, base and head of the rails are treated by an electrically driven pot brush.

- The movement of the brush towards the rails surface is performed pneumatically, the speed and pressure are continuously adjustable.
Flatness Measurement Gauge

• An optoelectronic, fully automated system for contactless measurement of rail’s flatness in real time.
• Measurement is performed by the use of five measurement heads.
• Acquisition of the measurement data is started by a light barrier and triggered by two incremental encoders.
• The measurement heads consist of a laser diode, which generates a light-section on the rails head.
• This section is monitored by a camera (part of the head), which passes the read information to the evaluation unit.
• Each of the five measurement heads delivers data for head shape and position of the rail.
**Flatness Measurement Gauge**

- From the data, the relevant measurement points (e.g. center of rail head, etc.) are calculated which guarantees correct measurement results even for lateral movements of the rails.

- A unique mathematical algorithm computes the true horizontal and vertical longitudinal shape of the rail surface out from the measurement data and gives guarantee of a correct calculation of the rail surface up to the ends.
Eddy current testing

• Method is based on the uses of the magnetic permeability of steel.

• Allows the continuous and automatic control of the head and of the feet of the rail at a speed of 1 m/sec.

• All the probes transmit information concerning the number of detected defects, their distance from the ends and their position within the section.
Eddy current testing

- Base of the rails to be tested is inspected by a four-channel rotating probe system, and the lower edges with two LMD segment coils. The base of the rail is also tested by two flat-coils for transverse defects.
- The distance between the probes and the surface as well as the test-track of the rail passing is kept constant by using adjustable guiding rollers, which are installed besides the probes.
- Rail head is tested by four rotating probes (two for side head and two for top head) to detect longitudinal defects and by 2 LMD coils to detect transverse flaws.
- The frame structure will be designed to take-up also two probes moving devices for segment coils for testing the upper edge of the base of the rail.
**Eddy current testing**

*Calibration*: Carried out with a sample rail (12 metres long) in which defects of known position and dimensions are artificially produced.

*Flaw Sensitivity and noise level*: 3:1 for automatic testing.

*Testing Electronics*:
- Eddy Current test equipment CIRCOGRAPH DS for testing of longitudinal orientated flaws on the outer surface of rails base.
- CIRCOSCAN H rotating head, stationary (4x5.0 mm probes; dia. 250 mm).
- Two LMD-flat coils, for the base of the rail 60 kg/m
- Two LMD-edge coils, for base (corner), special design for Rail type 60.
Test result

A sound rail

An unsound rail
Ultrasonic testing

• Ultrasonic examination is carried out in a continuous and automatic mode soon after the Eddy current test.

• System is equipped with 18+1 probe arrangement of the “squirter” type (with water jet) without direct contact with the rail that allow to check the whole section of the rail for its entire length.
**Test technique**

- Test employs the pulse reflection method with TR probes which are coupled to the test piece by means of a water gap.
- For testing the head of the rail two probes are positioned from each side. Moreover, the rail head is tested by three probes beaming from the tread of the rail.
- The rail web is tested by six TR probes located in two housings.
- The rail base is tested by two angle beam probes from underneath and by a TR probe beaming in the center axis of the rail, as well as by two angle beam probes from the top of the base of the rail.
- To avoid disturbances in the range of the rail stamps affecting the web test, a special angle probe is detecting the stamp area.
Test electronics

The NSP-VIS is specially for ultrasonic purposes design integrated multi-processor system. The salient features are:

• State-of-the-art development.
• Digital Depth Amplitude Compensation
• Fully digitized-data processing provides adjustment of all test parameters.
• Test parameters can be stored as sets according to different test specifications and rail sizes and can be recalled again.
• Self check and monitoring to ensure a high reliability and to ensure reliable test results.
Calibration

• Head : 4 x 2 mm FBH. One side drilled hole. 2 mm dia.

• Test Flaw for Rail Web : 6 x 2 mm FBH. Test flaws lie in the middle of the receiver crystal of the probe. Bottom faces of the flat-bottomed holes lie in the vertical center line of the rail web perpendicularly to the sound beam of the probe.

• Stamp Recognition : Stamp recognition requires a reflector corresponding to a vertical groove min. 0.75 mm depth, 2 mm width and 25 mm height. (less than 0.75 mm depth do not influence the testing).

• Base with Normal Beaming Probes : 1 x side drilled hole, 2 mm dia.

• Base with Angle Beam Probes : Notch of 2 mm depth, 3 mm width and 10 mm length. Test flaw is located in the transfer radius between web and base of the rail in a position of 45°.
Evaluation method

• According to type, the rails are tested with a pre-adjusted threshold determining the flaw size.
• Separate evaluation thresholds are assigned to the probes for head testing, web testing and base testing.
• Following each test pulse the US hardware transmits a signal to the evaluation computer if the pre-selected flaw threshold is exceeded or remained below.
• These results are statistically checked before they are accepted as actual indications.
• Flaws which are larger than the preselected limit are marked true-to-location separately for the rail head, base and web areas.
• A coupling failure is acoustically signaled by a horn.
Test result

A rejected rail

An accepted rail
**Paint marking unit**

- The detected defects are highlighted on the rail by means of an automatic paint spray.

- Consists of 4-spraygun installed at the end of testing line.

- Each kind of defect (straightness, surface defect, interior defects, etc.) is marked in different colour.

- One colour is frozen to mark the rail as tested on end.

- Ultrasonically detected defects only are marked in axial direction in their position.
Central processing system

- All results of the installed testing systems are transmitted to a central processing unit (CPS).
- CPS allows control and evaluation of data for quality assurance, product liability and for increasing production.
- Data output via screen-windows allows to combine and to visualize the generated results in many different ways.
- Trend and analysis windows support the evaluation of real-time and historical data. The selected real-time and historical product and process values as well as the results of data analysis can be shown in trend curves.
- The user defines the required select, sort and analysis criteria as well as the relevant data areas (date, measurement data, values, etc.).
- The selected data and the resultant outputs from the analysis functions are ported to predefined tabular formats.
Experience with the system

• Operational safety requires rails testing and monitoring during operation.

• System is being successfully used for couple of years for rail inspection in JSPL. Several serious defects, which could endanger operational fluency and safety, have been detected using this system and repaired or removed.

• Accurate recording of indications positions, their finding and re-evaluating by hand flaw detectors with contact probes and following repairs are much faster and reliable, which contributes to provision of operational fluency and safety on the track.
Conclusions
• Process innovations and product development initiatives at JSPL are focused unwaveringly on delivering the high-performance rails.

• Latest process technology, research and development, combined with the unrivalled metallurgical knowledge, computer modelling, computer-controlled heating and cooling, and novel roll-pass design to produce exceptional quality rails.

• The advanced non destructive testing & inspection and finishing systems that complete the JSPL rail manufacturing process ensure that all rail products meet the high standards required for all rail applications – from high-speed and heavy-haul networks to urban and industrial railways.
Thank you