Verbesserung der Wettbewerbsfähigkeit von Jackets durch innovative Fertigungsstrategien

Increasing competitiveness of Jackets by innovative manufacturing strategies

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Agenda

1. Salzgitter Group
2. Salzgitter Supply Chain Concept
3. Serial manufacturing of Jackets
   - Robotized welding of nodes
   - Robotized grinding of nodes
Company portfolio

Steel and Technology

- Strip products
- Steel Service Center
- Line pipes
- Heavy plates
- Precision tubes
- Sections
- Stainless tubes
- Engineering services
- Stockholding trading
- Injection molding machinery
- International trading
- Beverage filling plants

- Crude steel production 2014: 7.3 million tons; trading volume: 5.1 million tons
- External Sales cons.: 9.0 € billion / Employees: 23,555
Salzgitter Group

Company portfolio - Penetration Offshore Wind

Steel and Technology

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Competitive edge of Offshore Wind Tubular Companies with Bilfinger Cooperation

Salzgitter Offshore Wind Expertise

- **Strip Steel**
- **Plate / Section Steel**
- **Tube**
  - **Salzgitter Flachstahl**: Base material for HFI and Spiral tubes
  - **Mannesmann Grobblech**
  - **Ilsenburg Grobblech**: Base material for Monopiles and large diameter tubes
  - **Europipe**: LSAW pipes up to OD 1524/ wt 50mm (marked leader)
  - **MLP**: HFI pipes up to OD 610 / wt 25.4mm
  - **SMGR**: Spiral pipes up to OD 1676 / wt 25.4mm

Cooperation

- **Combined Development of**
  - modular Jacket design and secondary steel system
  - Robotized welding of nodes
- **Combined market approach**
  - Complete foundation structure including TP will be marketed by BMO
  - Jacket components such as nodes and pipes will be marketed by Salzgitter

St3 Offshore
Supply of component kid composed of
- Standardized tubes
- K, Y, X- nodes
- Sections / frames
- …

Jackets can be build out of sections, or from components at a site or port local to a wind farm

Applicable for all Jacket fabricators and without any design preferences
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Serial manufacturing of Jackets

Standardized tube
- Based on pipeline application
- Fully automated welding and NDT
- High productivity (up to 200 pipes / shift)
- Low geometrical tolerances → reduction in welding / assembling time
- High cost competitiveness against JCO pipes → 20% to 30%

Robotized welding of nodes
- Tubular welds are cost driver within jacket manufacturing
- Robotized welding of nodes leads to:
  - acceleration within production
  - uniform weld properties
  - improvement of fatigue by inside welding and optimized weld shape

Assembly of components by orbital welding
- Cost efficient welding of butt joints
- Significant reduction in cost/time compared to manual welding
Automated fabrication of nodes – general approach

- Replacement of manual welding by robots
  - reduction in welding time and cost
  - sustainable quality improvements by controlled processes (heat input, weld profile)
  - efficient inside welding

- Welding of stubs onto chord by
  - Manipulator:
    Movement of node enables welding always in 1G/PA Position
    - high welding speed, lower welding defect rate
  - Robot unit:
    Utilization of high productive tandem-welding
Automated fabrication of nodes – general approach
Main welding unit at St3
Pre-fabrication of nodes – general approach

1) Semi-automatic loading of chord / stubs

2) Manual tack welding

3) Pre-heating + Robotized inside root welding → backing layer

4) Outside welding
   First outside layer (hot pass) to be carried out with sufficiently high energy to guarantee:
   • full penetration weld
   • prevention of root failure
   • Filling passes with high deposition rate
   • Cap layer with oscillated welding head to generate smooth weld profile
Further Potentials – under investigation

- **Optimization of weld geometry / notch effect**
  - Reliable modeling of weld geometry such that
  - smooth transition tangent to the parent material \(\rightarrow\) negligible notch effect / **fatigue improved**
  - Monitoring / memorizing of surface notches / weld profile via camera system for each stub

- **Inside welding of nodes (applicable)**
  - Currently not used for Jacket manufacturing do to point to point approach
  - Robotized pre-fabrication of nodes enables efficient inside welding
  - Improvement of fatigue strength especially when outside weld profile / notch effect is improved
  - Backing layer: guarantee of full penetration weld
Weld geometry of robotized nodes
Weight reduction due to smooth shape of welds

Smooth shape - Stress distribution due to out of plane moment

Normal weld shape - Stress distribution due to out of plane moment

Improved weld shape

- leads to a damage reduction by factor $1.77 \div 1.96$
- Weight reduction of $5 \div 10\%$ for whole primary steel
Weld toe grinding

- Local grinding of the weld toes below any visible undercuts increase fatigue life significantly.
- The grinding depth should not exceed 2 mm or 7% of the plate thickness, whichever is smaller.
Automated weld toe grinding – feasibility

I. Robotized welding of node

II. Extraction of samples

III. 3D Profil Scan

IV. Derive of Track Curve
V. Automated grinding of nodes segment

- **Next Steps**
  - Calculation of mass reduction of Jacket based on DNVGL rules
  - Full Scale node grinding test
Thank you!