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Numerical Modeling of the IKT-Pipe Jacking Simulator ND 1600

Working Group for Structural Analysis and Computer Science

- Preliminary Report -

Client: IKT – Institute for Underground Infrastructure

Contractor: University of Applied Sciences Department of Civil Engineering

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Research Goals

Assistance for experimental work to

- **explain measurement phenomena like displacements and jacking forces,**
- **plan further steps and**
- **define needs of additional measure data**

Finite Element Method is applicable for the explanation of

- **coupled pipes displacement phenomenon,**
- **stress distribution in intermediate layers including non linear geometrical and physical behavior and**
- **forces and friction between pipe and soil**

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1. Description of the Finite Element Model

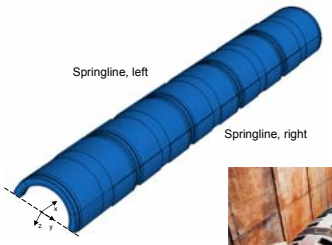

Fig. 1 Symmetric Finite Element Model with dimensions of the IKT-Pipe Jacking Simulator: ND 1600, L = 16.2 m

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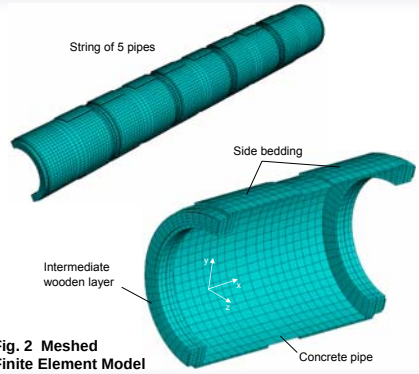

Fig. 2 Meshed Finite Element Model

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2. First result, Load case „Curve"

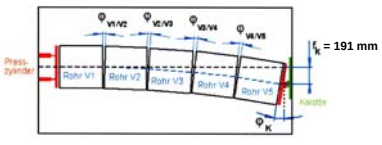

Fig. 3 Pipe arrangement for load case „Curve"

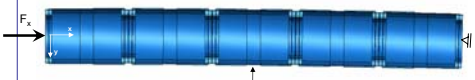

Fig. 4 Finite Element Model for load case „Curve"

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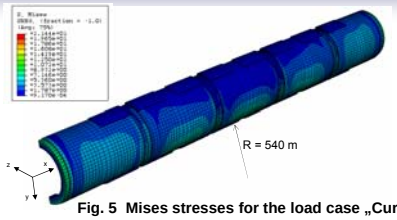

Fig. 5 Mises stresses for the load case „Curve" (scaling factor 1)

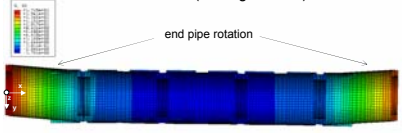

Fig. 6 Deformations in y-direction (scaling factor 15)

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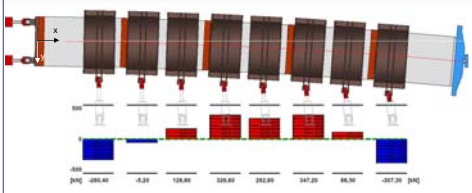

Fig 7a Jacking forces F_y, measured at the simulator

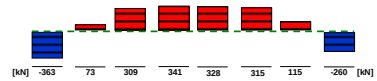

Fig. 7b Jacking forces F_y, calculated by the FE-Model

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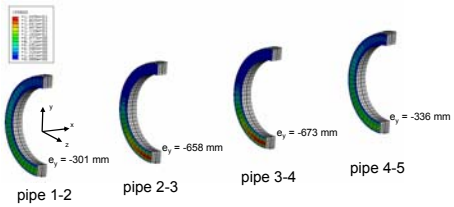

Fig. 8 Distribution of contact stresses σ_x in the intermediate wooden layers and eccentricity e_y of the axial forces

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3. Conclusion

3.1 Recommendations for further experiments

- Look for equilibrium $\sum F_y = 0$ in the horizontal direction
- Deformations and flexibility due to transversal loads F_y
- Evaluate angle differences and gaps width between neighbouring pipes
- Measure orthogonality of the pipe end planes after dismantling the simulator

3.2 Phenomena in real pipe jacking situations

- Eccentricity of the axial forces and rotation of the end pipes in curves
- Bedding reactions of the end pipes in the surrounding soil
- Friction caused by these reactions to be added to the total jacking force $\sum F_x$

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References

1. IKT – Institut für unterirdische Infrastruktur: Forschungsantrag
2. ABAQUS/Standard, Version 6.6, Hibbitt, Karlsson & Sorensen, Inc., Handbuch, 2006
3. Scherle, M.: Rohrvortrieb, Band 2: Statik, Planung, Ausführung. Bauverlag GmbH, Wiesbaden und Berlin (1977)
4. Stein, D.: Grabenloser Leitungsbau. Ernst & Sohn, Berlin 2003
5. Verburg, N.: An analysis of friction by microtunnelling. Final report TU Delft, Dec. 2006
6. Bosseler, B.; Liebscher, M.; Redmann, A.: Simulation von Rohrvortrieben im Maßstab 1:1. 3R international (45) H. 12/2006
7. Arbeitsblatt DWA-A 125: Rohrvortrieb und verwandte Verfahren. Entwurf Mai 2006
8. Arbeitsblatt ATV-A 161: Statische Berechnung von Vortriebsrohren. Jan. 1990 sowie Entwurf 2. Auflage 2007