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FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF ELECTROMECHANICAL, SYSTEMS AND METAL ENGINEERING (EMSME)
SOETE LABORATORY

RESTERENDE LEVENSDUUR VAN GELASTE BUISVORMIGE VERBINDINGEN OP BASIS VAN 3D SCANS

Ir. Jelle Plets
Promotoren: Prof. dr. ir. Wim De Waele, dr. ing. Kris Hectors

15/05/2024

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SOETE LABORATORY

PROJECTEN

FlexWind

Partners:

Financiering:

Firmest

Partners:

+ Industry advisory board

Financiering:

UGENT TEAM

Prof. Wim De Waele

- Supervisie
- Coördinatie

Dr. Kris Hectors

- Supervisie
- Ondersteunend onderzoek

Ir. Jiacheng Qi

- Fundamenteel onderzoek
- Project: Firmest

Ir. Jelle Plets

- Fundamenteel onderzoek
- Project: FlexWind

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DOEL

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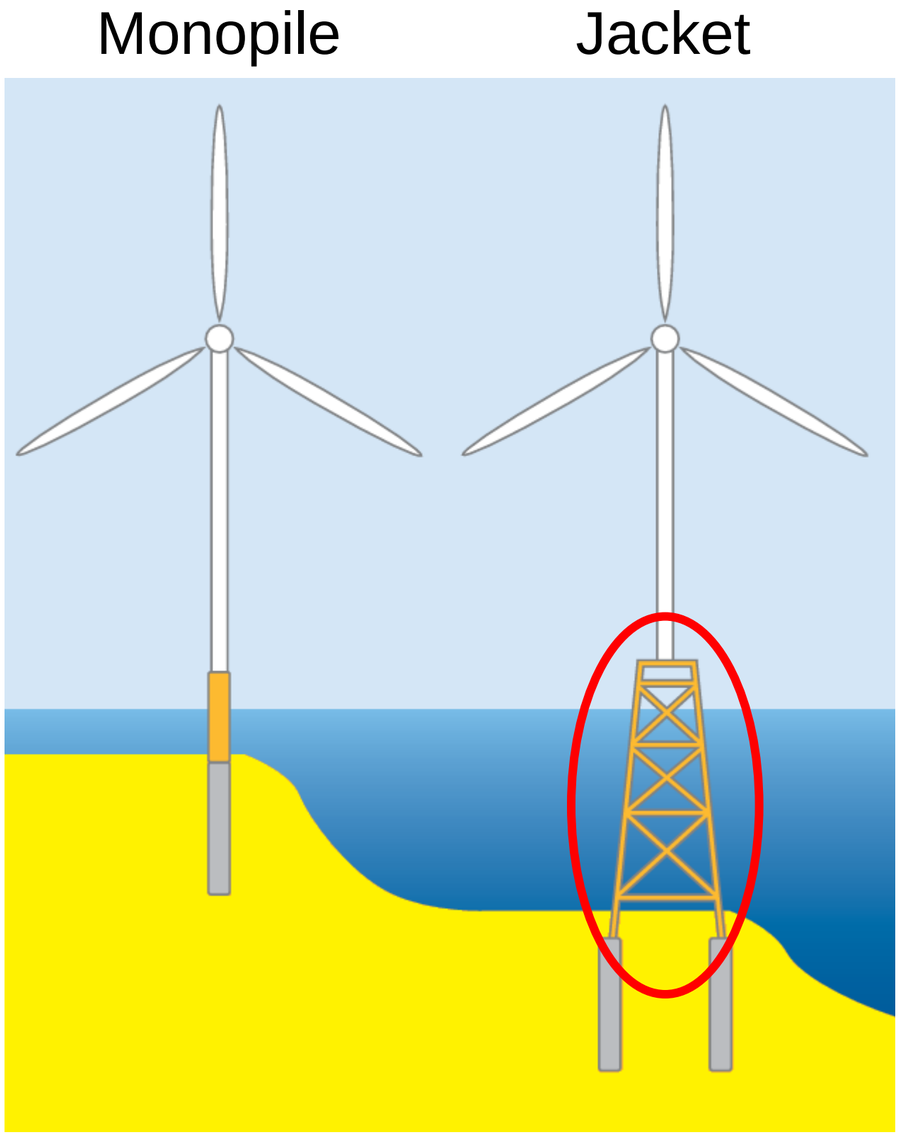
CONTEXT

Offshore windturbines

Substructuren

Jackets

Buisvormige verbindingen



http://www.ewea.org/fileadmin/files/library/publications/reports/Deep_Water.pdf

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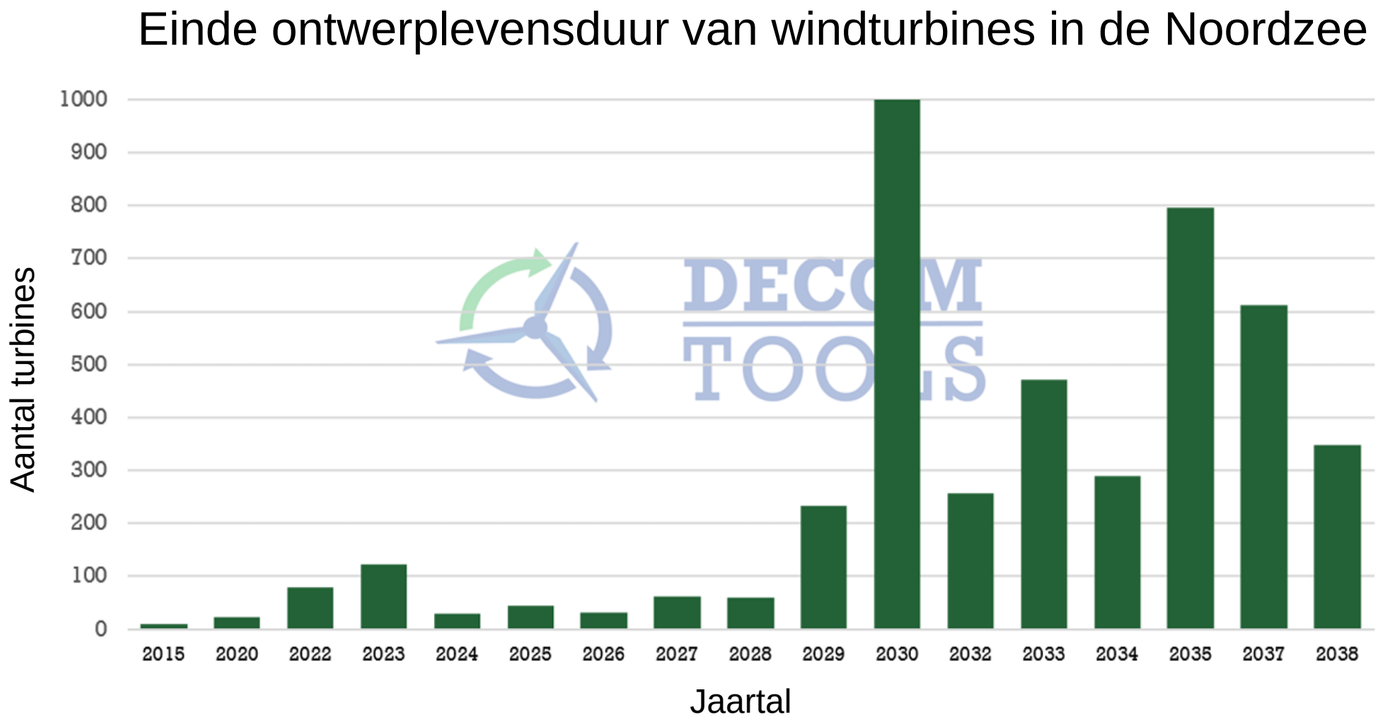
MOTIVATIE

3 scenario’s:

- Ontmanteling
- Levensduurverlenging
  → Economisch
  → Ecologisch
- Repowering



https://safety4sea.com/offshore-wind-decommissioning-in-north-sea-to-increase-from-2020-new-study-shows/

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LEVENSDUURVERLENGING

Onderhoud / herstel

Te conservatief ontworpen

→ Veiligheidsfactoren ↓

→ Verlenging ‘operationele’ levensduur

Nauwkeurigere analyse van

Vermoeiingsweerstand

Levensduurbeoordeling

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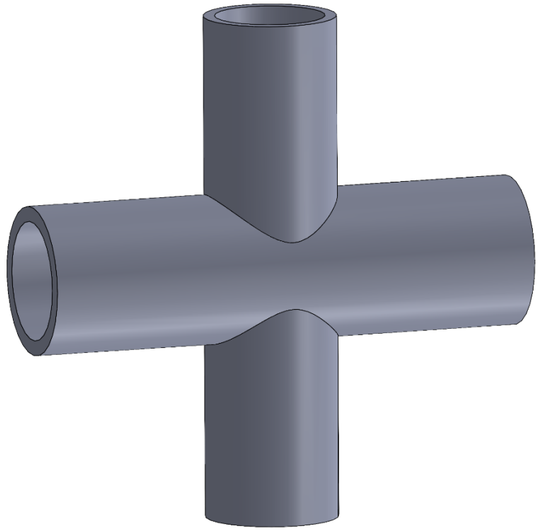
NAUWKEURIGERE ANALYSE

Ontwerpgeometrie

Perfect ronde buizen

Geïdealiseerde lassen



VS

Werkelijke geometrie

Ovaliteit buizen

Werkelijke lasgeometrie

Corrosie

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METHODOLOGIE

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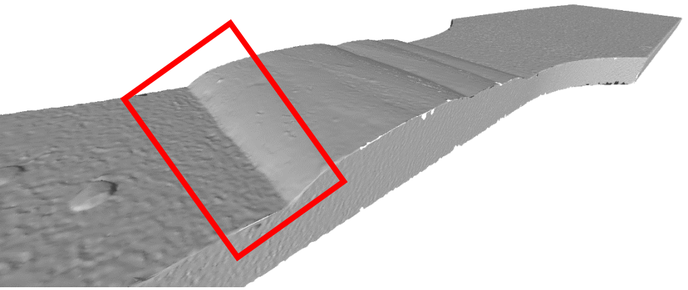
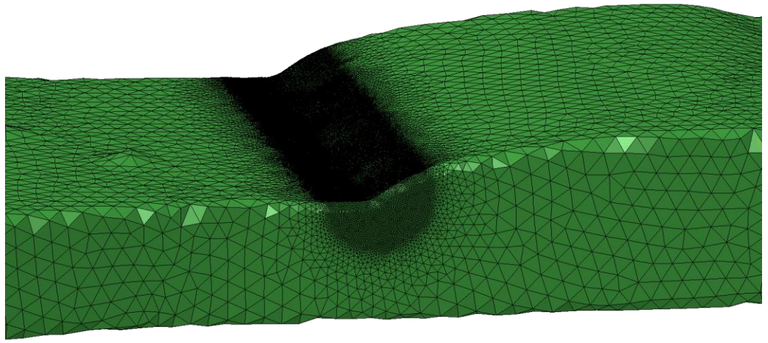
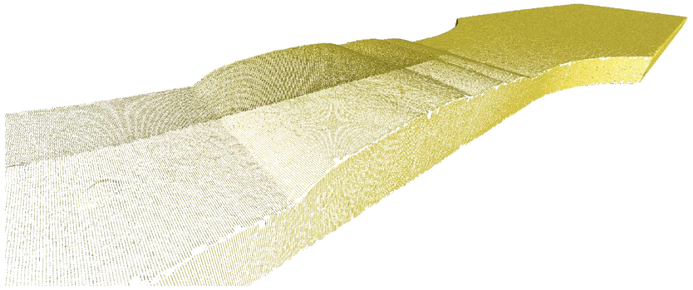
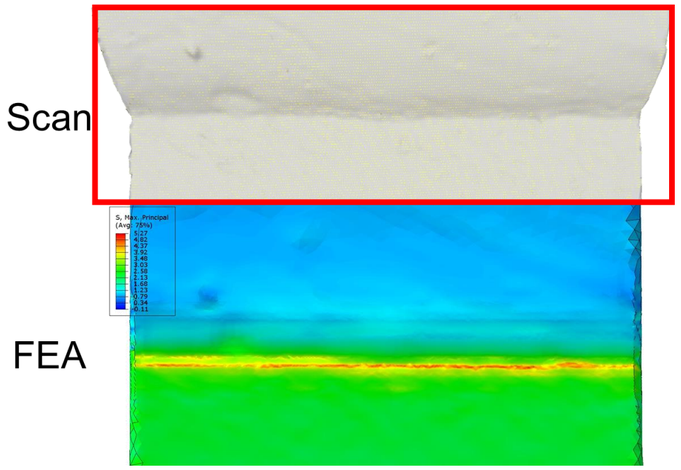
METHODOLOGIE





3D laserscan → Puntenwolk → Eindige-elementenmodel → Lokale spanning





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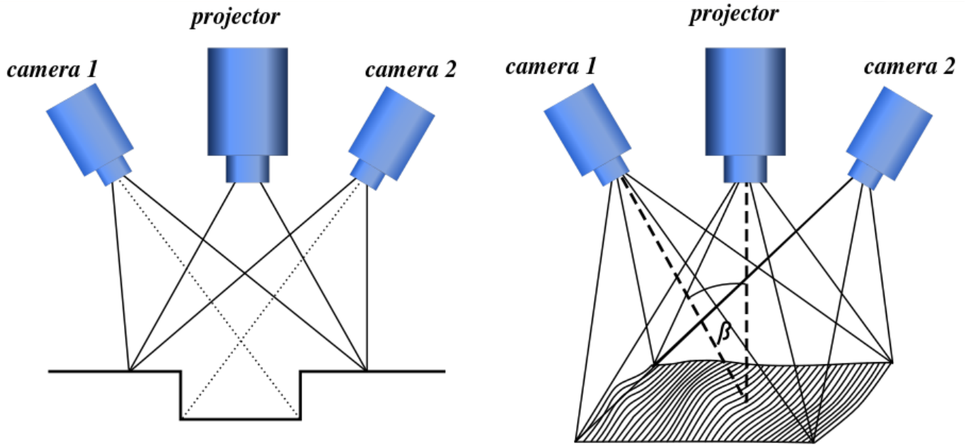
3D LASERSCAN

- Draagbare 3D laserscanner
  (Creaform HandySCAN3D)

- Gestructureerd blauw licht
  → Minder reflectie

- Enkel buitenoppervlak
  → Uitdaging



https://www.3d-scantech.com/what-is-structured-light-3d-scanning/

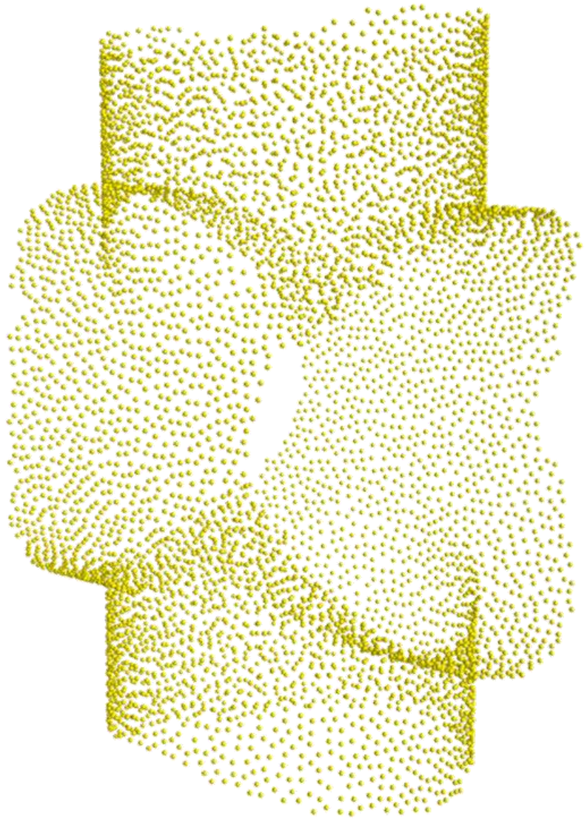
PUNTENWOLK

- Output scan

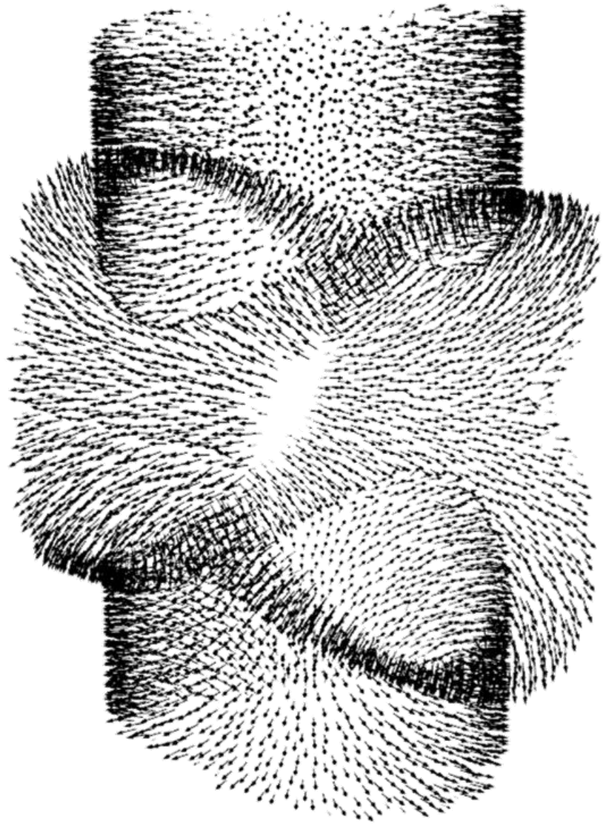
- Punten en normaalvectoren
  → Manipulatie
  → Reconstructie

- Input eindige-elementenmodel

Puntenwolk



Normaalvectoren

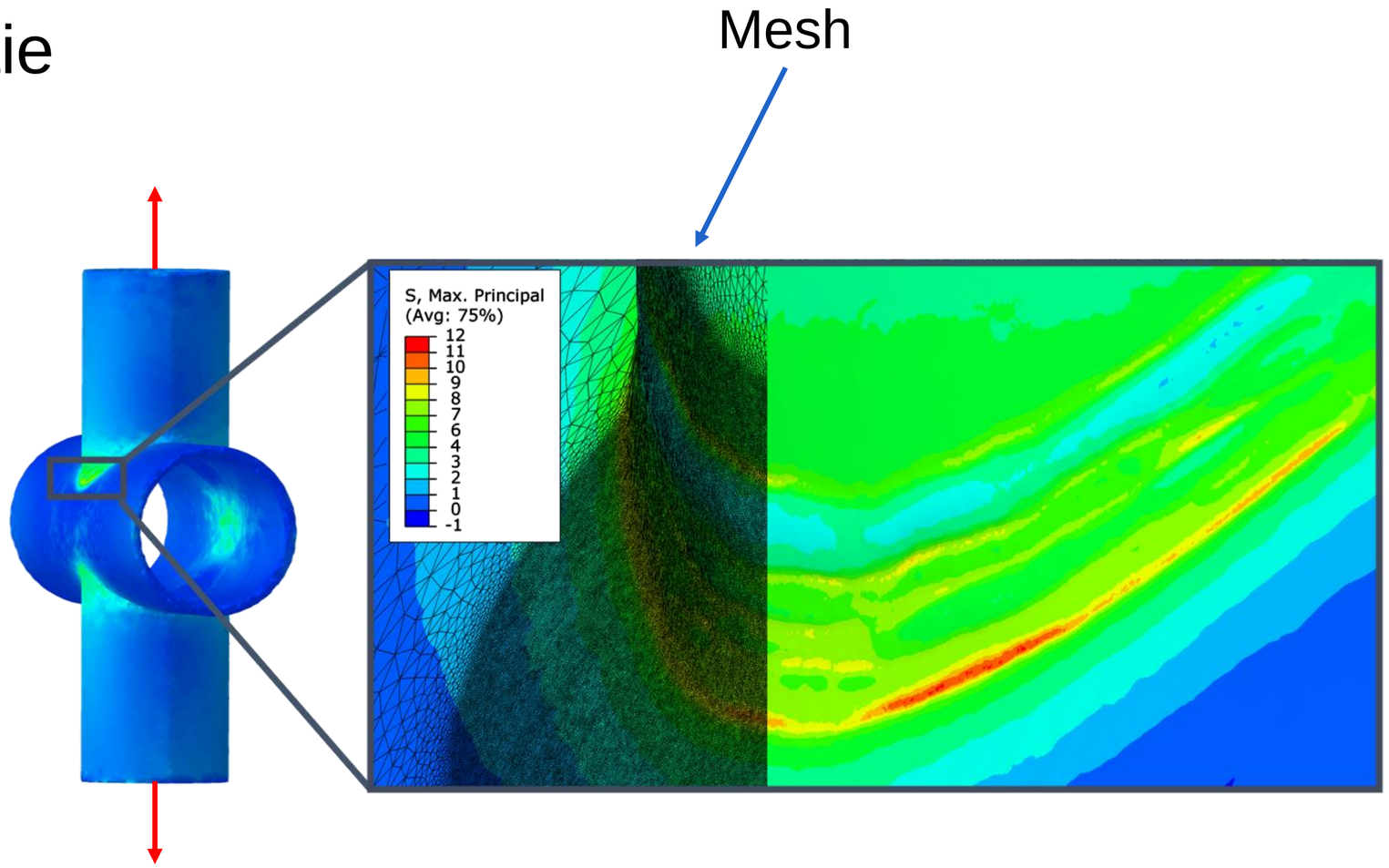


EINDIGE-ELEMENTENMODEL

- Spanningsconcentratie
  → Aan de lastenen

- Normen:
  Discrete punten rondom las

- Convergentie
  → Uitdaging



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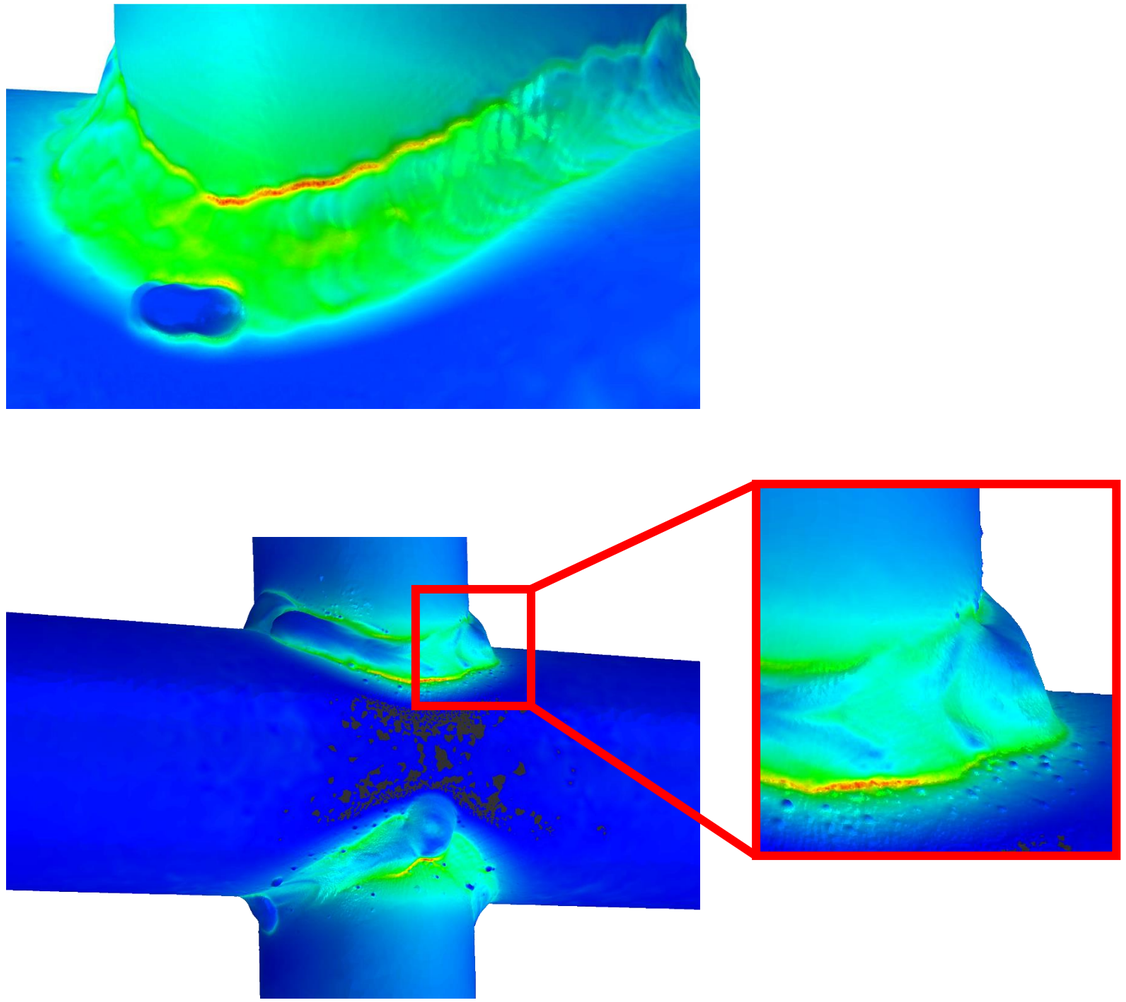
3D laserscan → Puntenwolk → Eindige-elementenmodel → Lokale spanning

LOKALE SPANNING

- Complexe spanningspatronen en -gradiënten
- Maximumspanning
  → Singulariteit
- Normen:
  Spanning op afstand van de lasteen
  → Lokale methodes
- Correcte lokale spanning?



CASE: ANALYSE VAN EEN OFFSHORE JACKET

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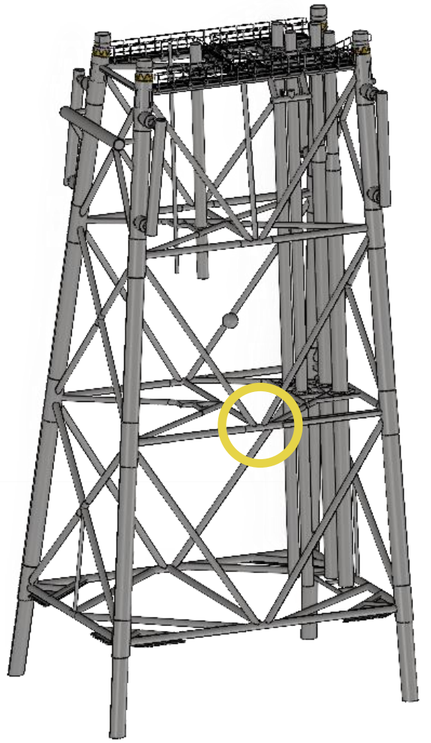
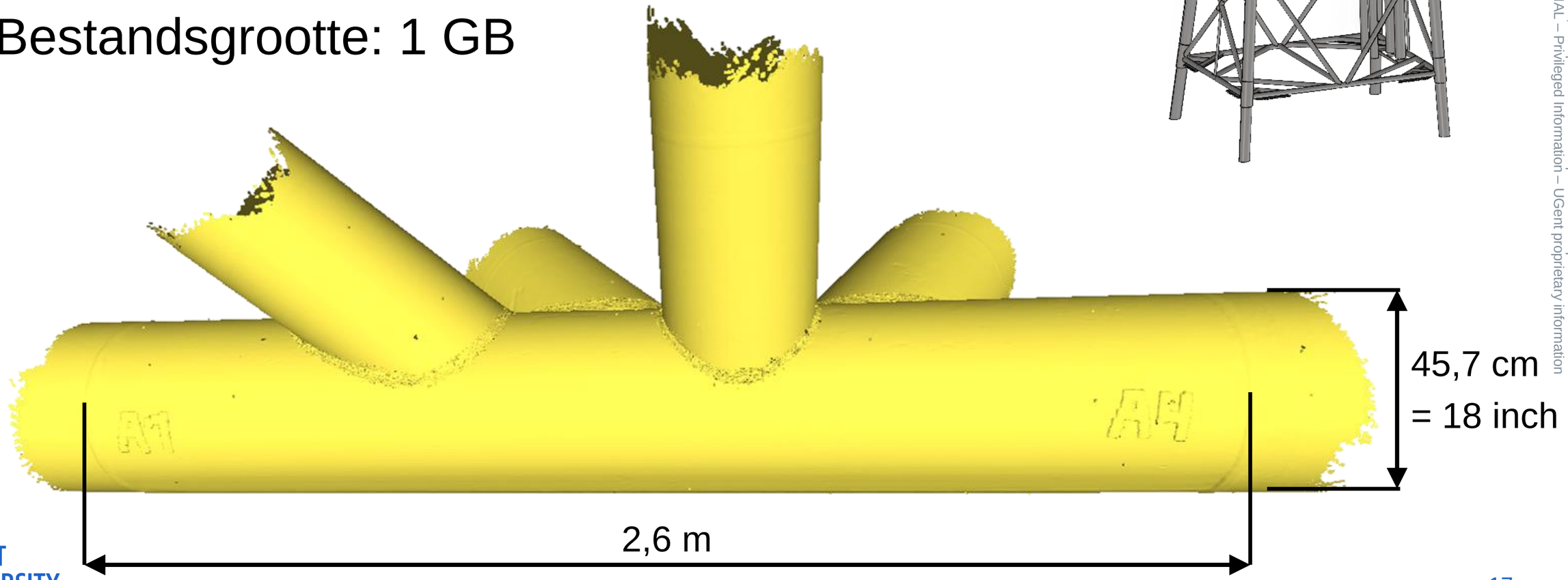
SCAN BUISVERBINDING JACKET

- 16,5 miljoen punten
- Bestandsgrootte: 1 GB





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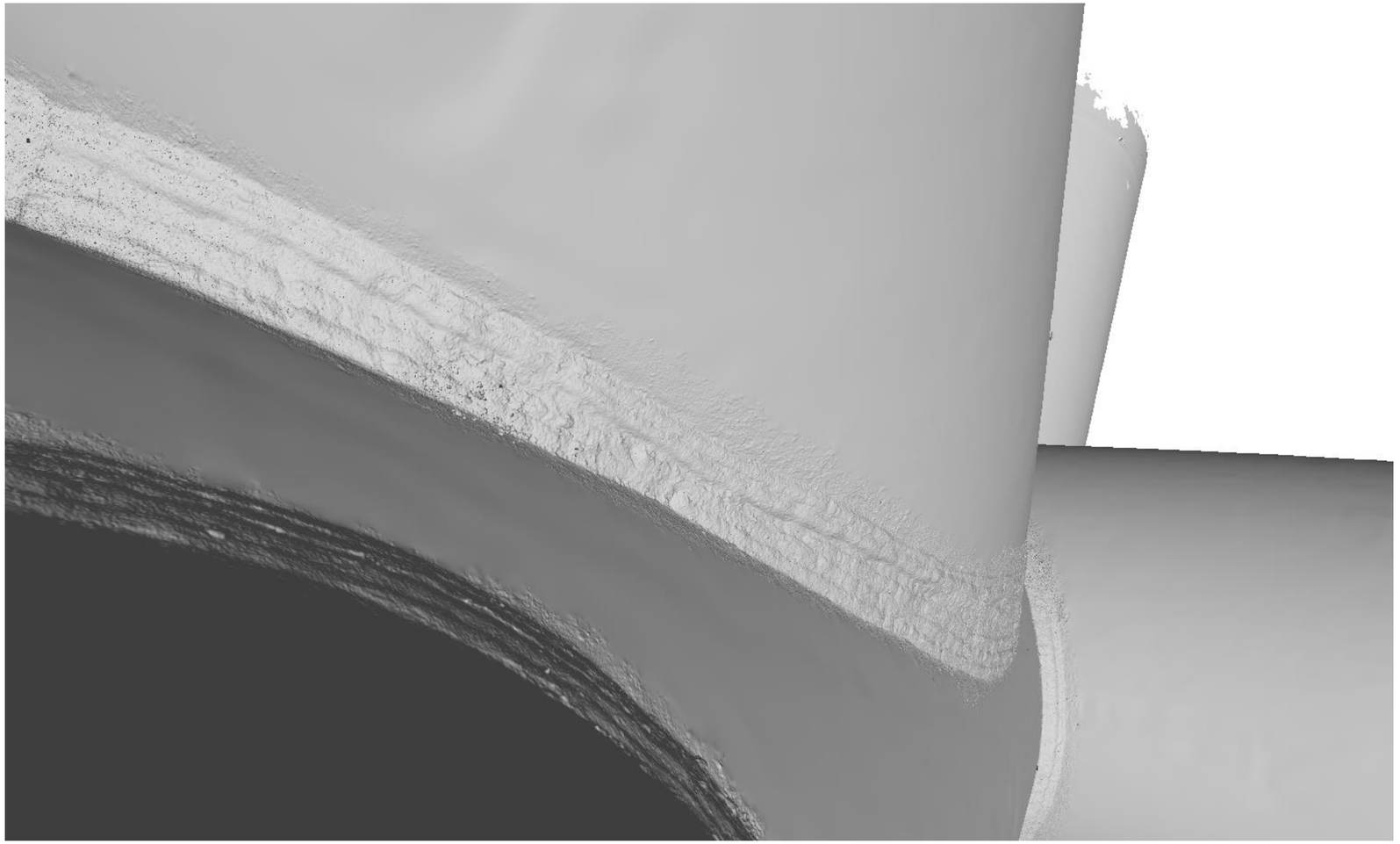
SCAN BUISVERBINDING JACKET



Resolutie:

- Globaal: 2 mm
- Lassen: 0,125 mm

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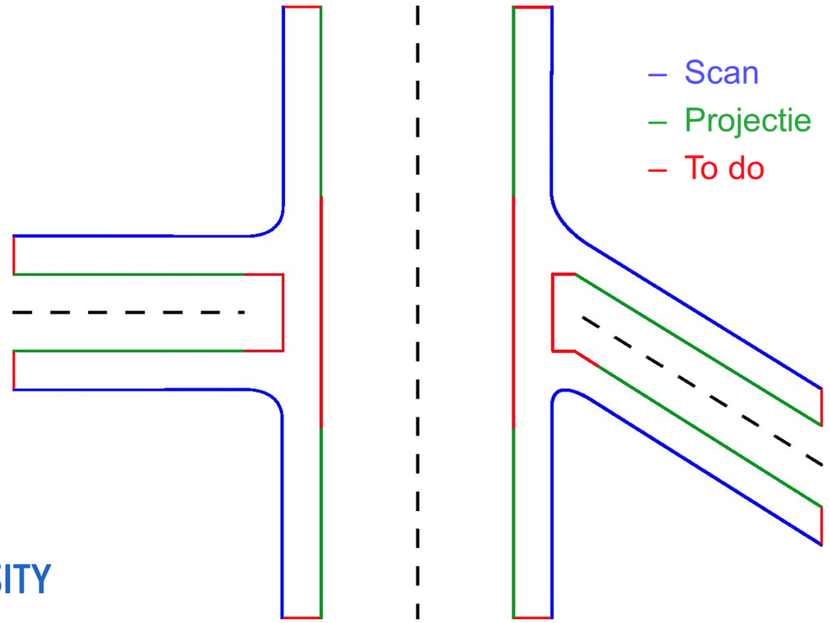
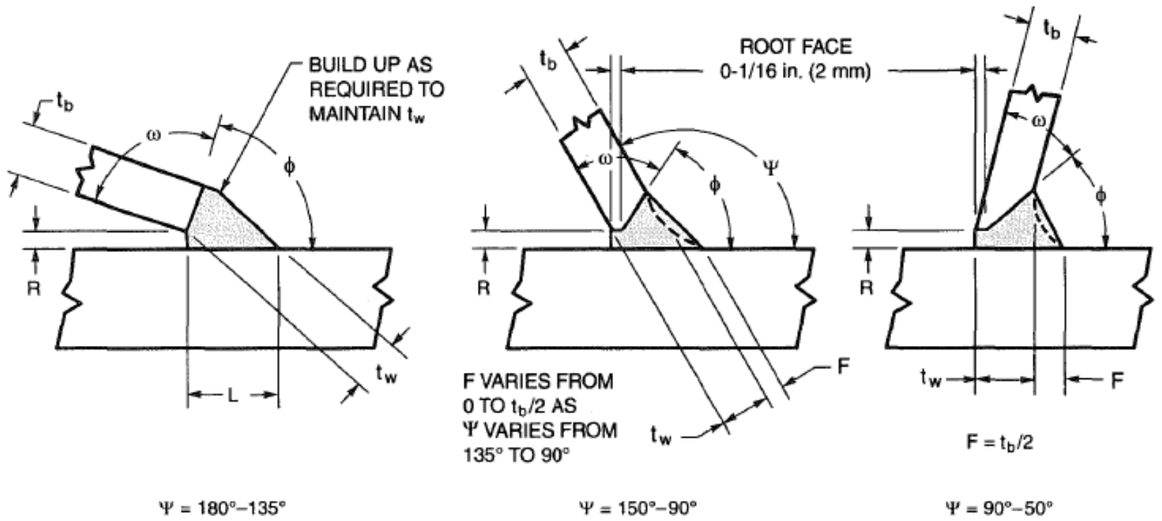
RECONSTRUCTIE

Doelen	Uitdagingen	Aannames
Ovaliteit van de buizen behouden	Binnenopp. niet gescand	Constante wanddikte projectie
	Binnenopp. minder corrosie	Binnenopp. afvlakken
Beschouw geometrie laswortel	Laswortel niet gescand	Volgens norm (AWS D1.1)
Corrosie(putten) behouden	Ruis in scan	Verwijderen uitschieters





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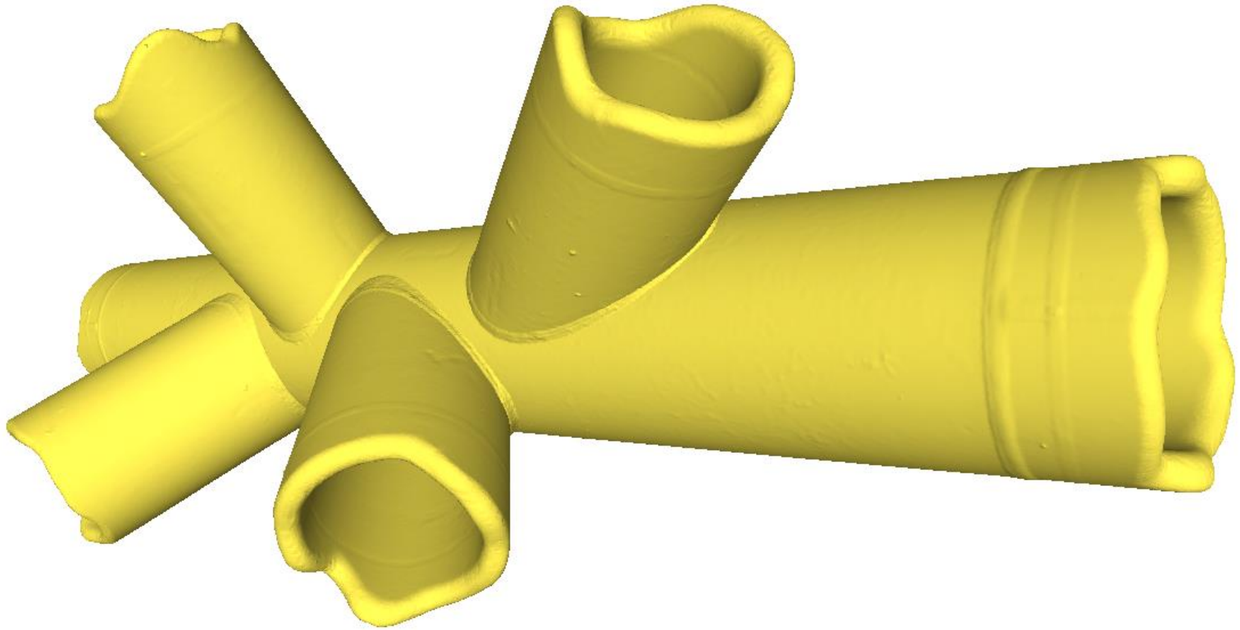
EERSTE RESULTATEN

Werkelijke geometrie

Reconstructie voor eindige-elementenmodel



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VOLGENDE STAPPEN

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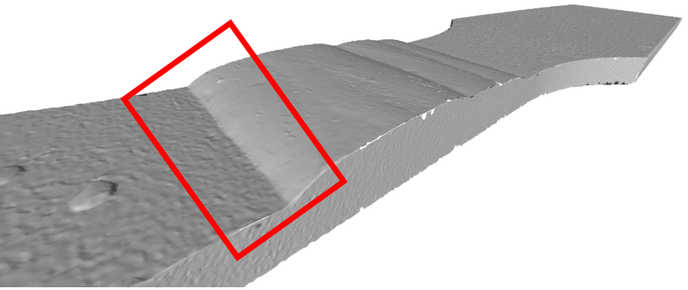
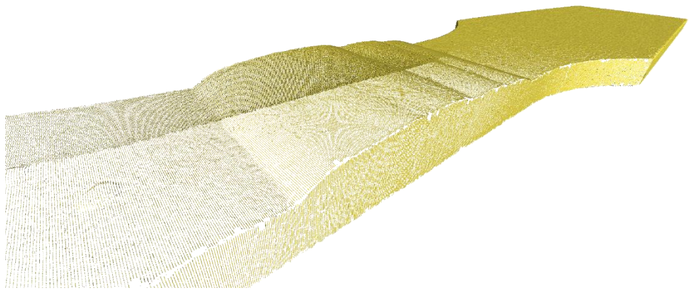
METHODOLOGIE

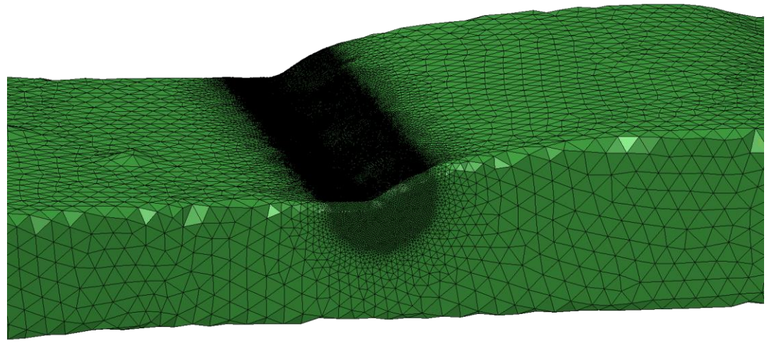


3D laserscan

Puntenwolk



Eindige-elementenmodel

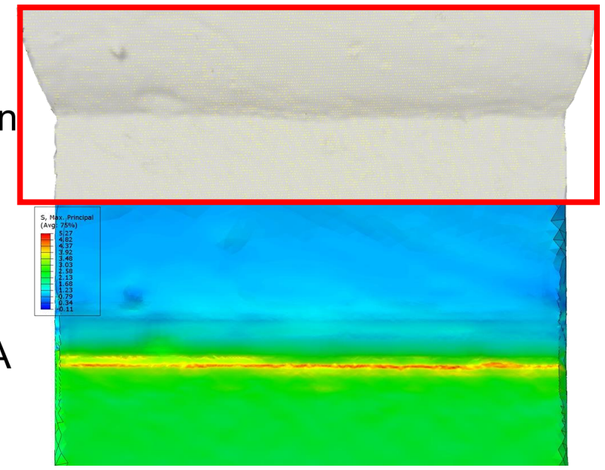


Vermoeiings-analyse

Belastingen

Lokale spanning

Scan



FEA

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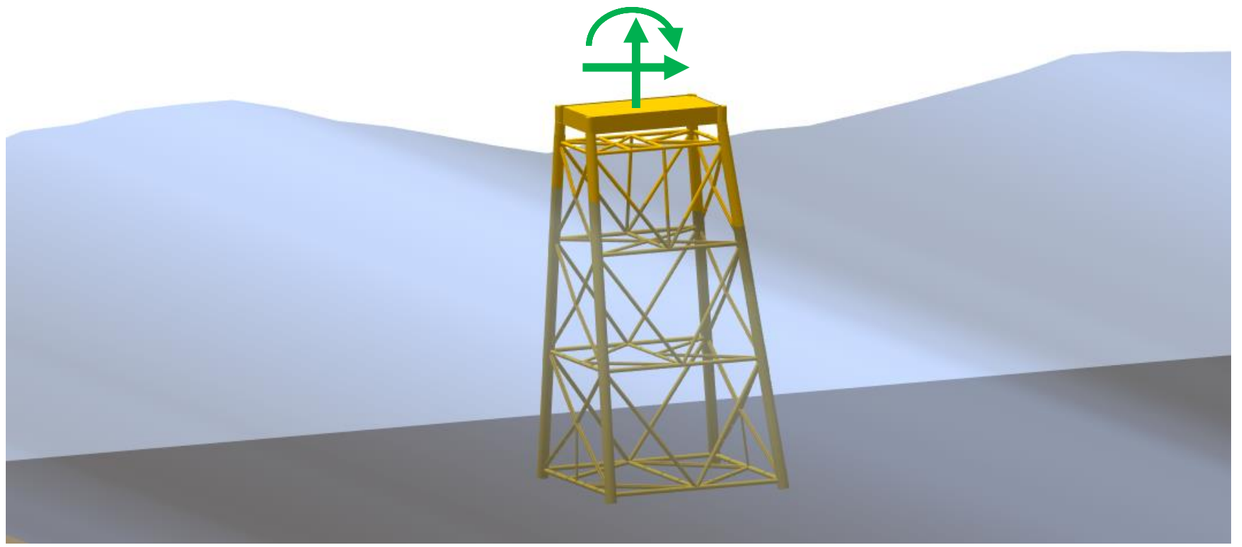
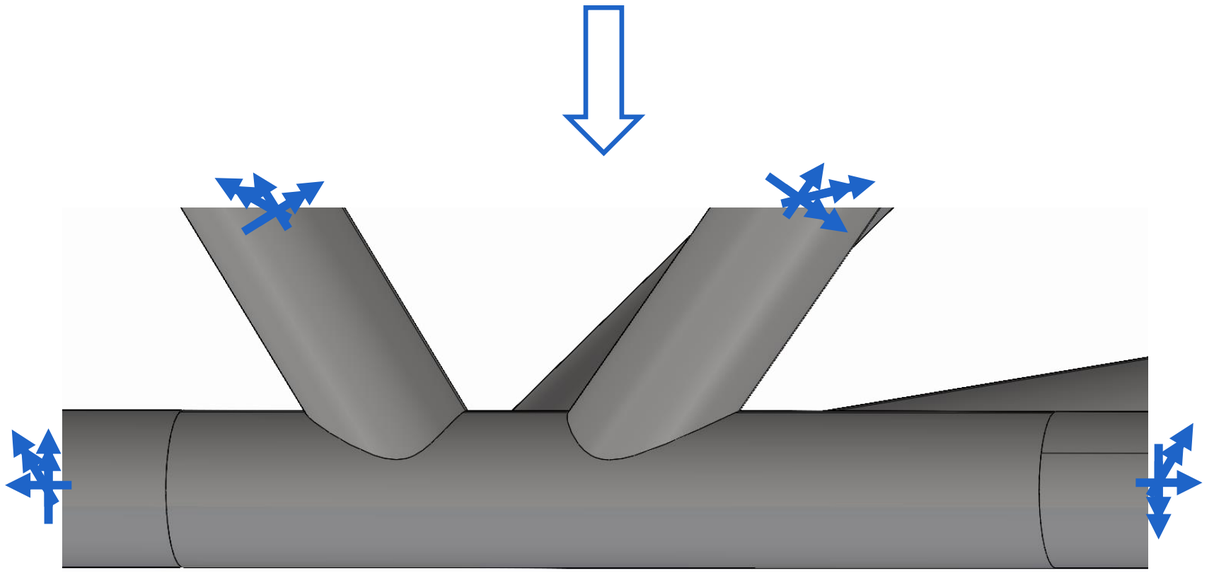
BELASTINGEN

- Globaal model
  - → Golven, stroming, wind
  - → Belasting door topstructuur

- Belastingen in iedere buis
  - → Axiaal en 2 momenten
    (in en uit het vlak)
  - → Nominale spanningen





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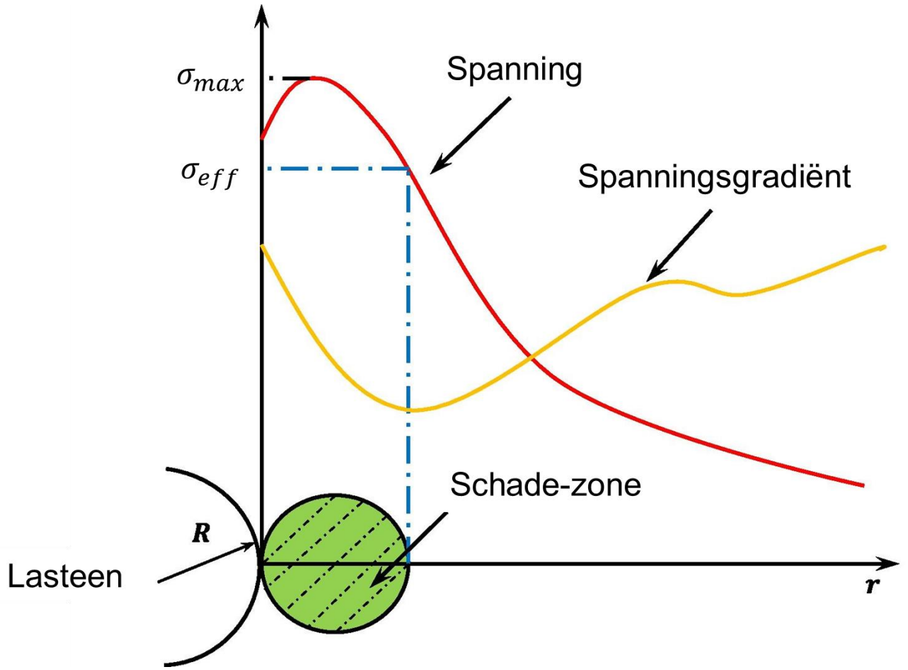
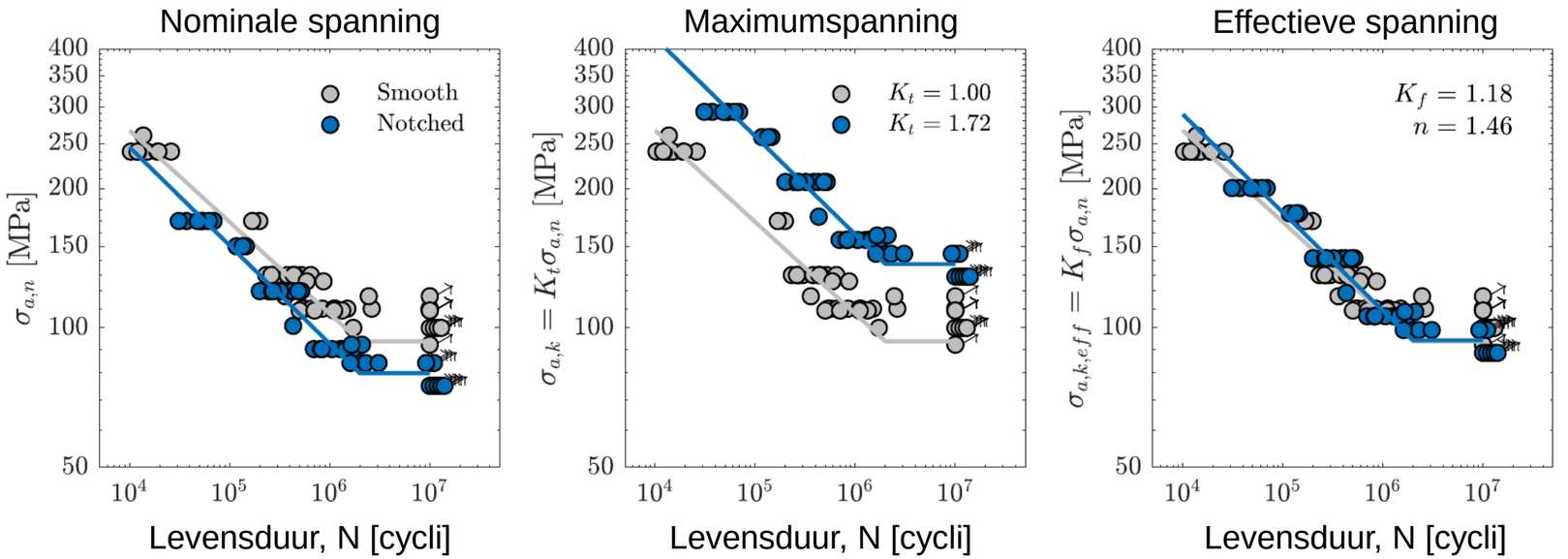
VERMOEIINGSANALYSE

- Levensduur ~~=~~ maximumspanning
- Levensduur ↔ effectieve spanning
  - → Fictieve spanning
  - → Op basis van spanningsgradiënt



Zhu S-P, Ye W-L, Correia JA, Jesus AM, Wang Q. Stress gradient effect in metal fatigue: Review and solutions. Theor Appl Fract Mech 2022;121:103513.



Pedersen MM. Introduction to metal fatigue—concepts and engineering approaches, Department of Engineering, Aarhus University; 2018. https://doi.org/10.13140/RG.2.2.25216.28163

CONCLUSIE

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CONCLUSIE

Levensduurverlenging

Economisch + ecologisch

Nauwkeurigere analyse

Veiligheidsfactoren ↓

‘Operationele’ levensduur ↑

Werkelijke geometrie

3D scans

Ovaliteit buizen

Werkelijke lasgeometrie

Corrosie

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