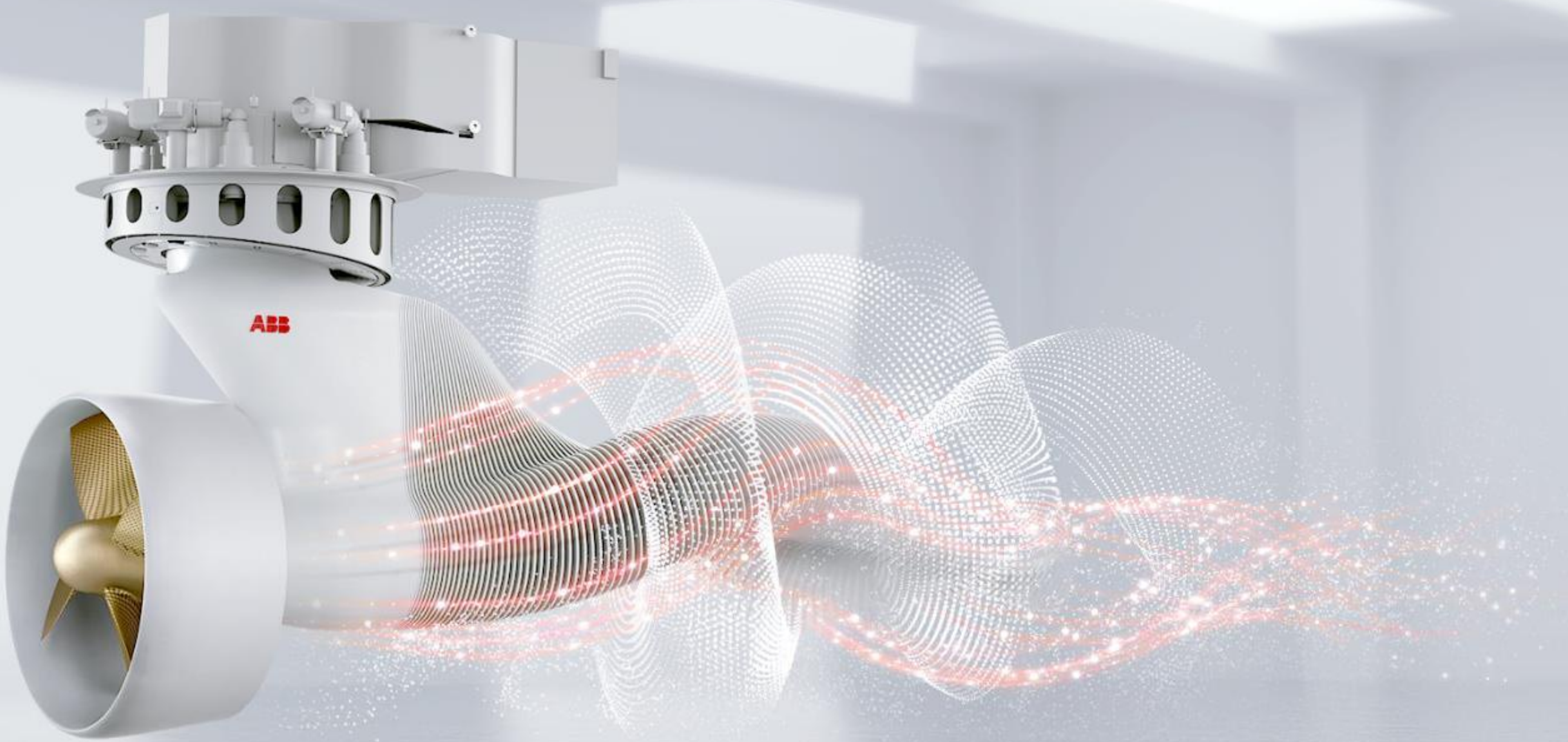


BU MARINE PORTS - 2018

Azipod® D presentation
Siemens Simcenter Nordic Conference 2018

Integrated marine solutions for more productivity

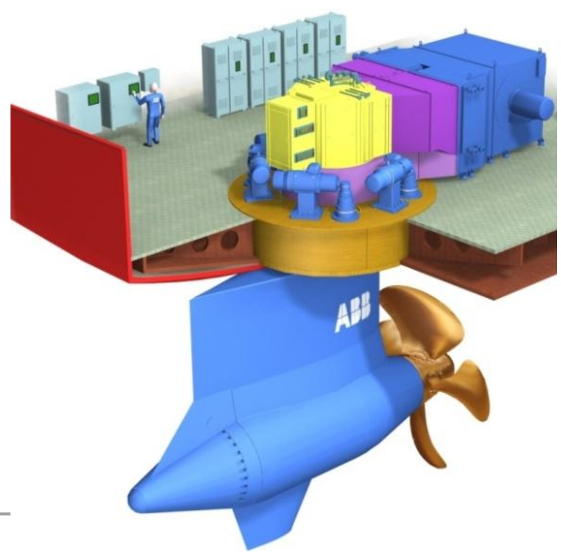
Teemu Rauhala, Structural Analysis

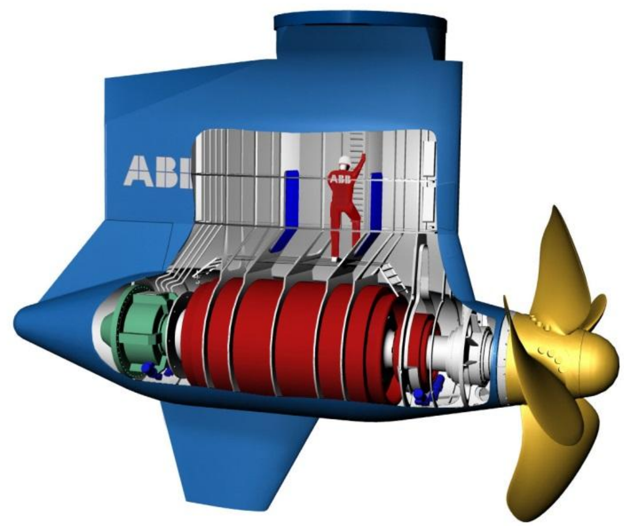
Agenda

- Azipod® technology
- Development history
- Video
- Azipod® D propulsor
- Dimensioning principles
- FE analysis with Simcenter™ 3D

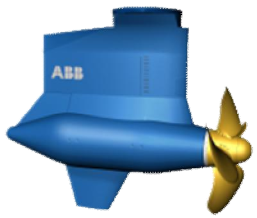
Azipod® technology

- Azipod® is a registered trade mark of ABB
- Azimuthing electric propulsion and thruster system
- Electric motor is inside a submerged pod
- Speed controlled fixed pitch propeller
- Propulsion module can be rotated 360 degrees around its vertical axis





Development History of ABB Propulsion Products



2015 Azipod® D introduction

2011 New Azipod® C factory in Shanghai

2010 Order for n:o 100 Azipod® vessel,

2008 Azipod® XO introduction

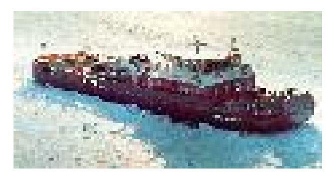
2007 New Azipod® factory in Helsinki

2004 Azipod® CZ deliveries for drilling rig

2001 CRP Azipod® introduction

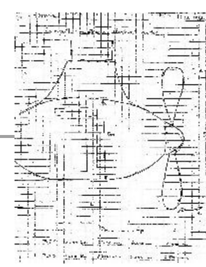
2000 Azipod® C introduction

1995 1st Cruise Vessel application, "*Elation*"



1994 1st Icebreaker application "*Röthelstein*"

1989 Prototype installation "*Seili*"



1987 Original Azipod® Idea

ABB

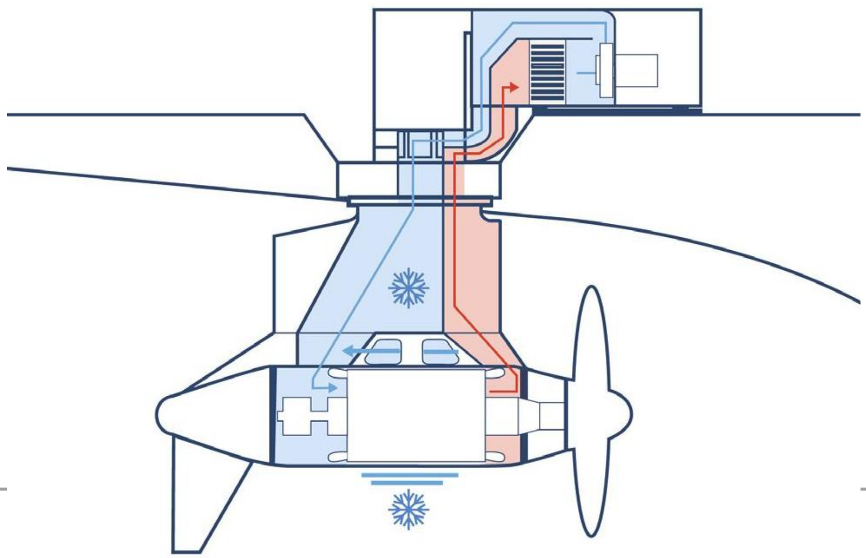
Video

ABB Azipod® Propulsion:

https://www.youtube.com/watch?v=skMd8Yi6th8

Azipod® D

- Hybrid cooling (air / water cooled)
- Electrical steering
- Power range up to 7 MW
- Available without nozzle (DO -series) for high speed propulsion or with a nozzle (DZ –series) for low speed, high thrust applications
- Propeller diameter in the presentation example is 3.6 m
- The results and illustrations in this presentation are based on early stage feasibility studies and not the final product



Dimensioning principles

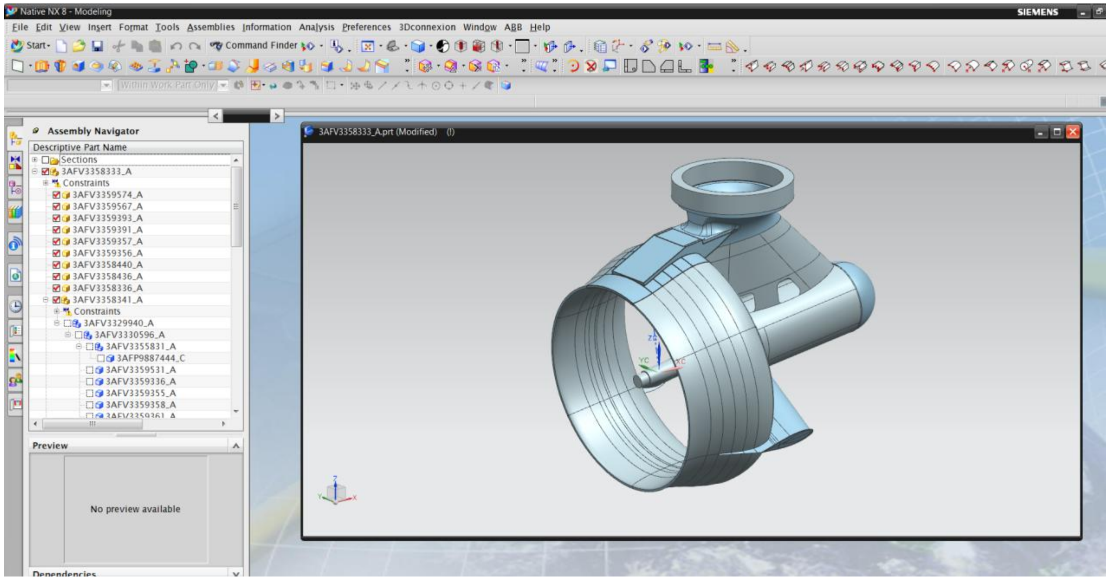
- The load cases considered are divided to:
  - High cycle loads, typically representing normal cruising (autopilot steering course keeping)

  - Low cycle loads (steering system performance tests, crash stop)
    - Recommended practice for crash stop is to perform a pod-way crash stop; by turning the Azipods® instead of reversing the rotation

  - Extreme and special loads (case dependent such as propeller blade break, breaking order at collision, DP operation etc.)

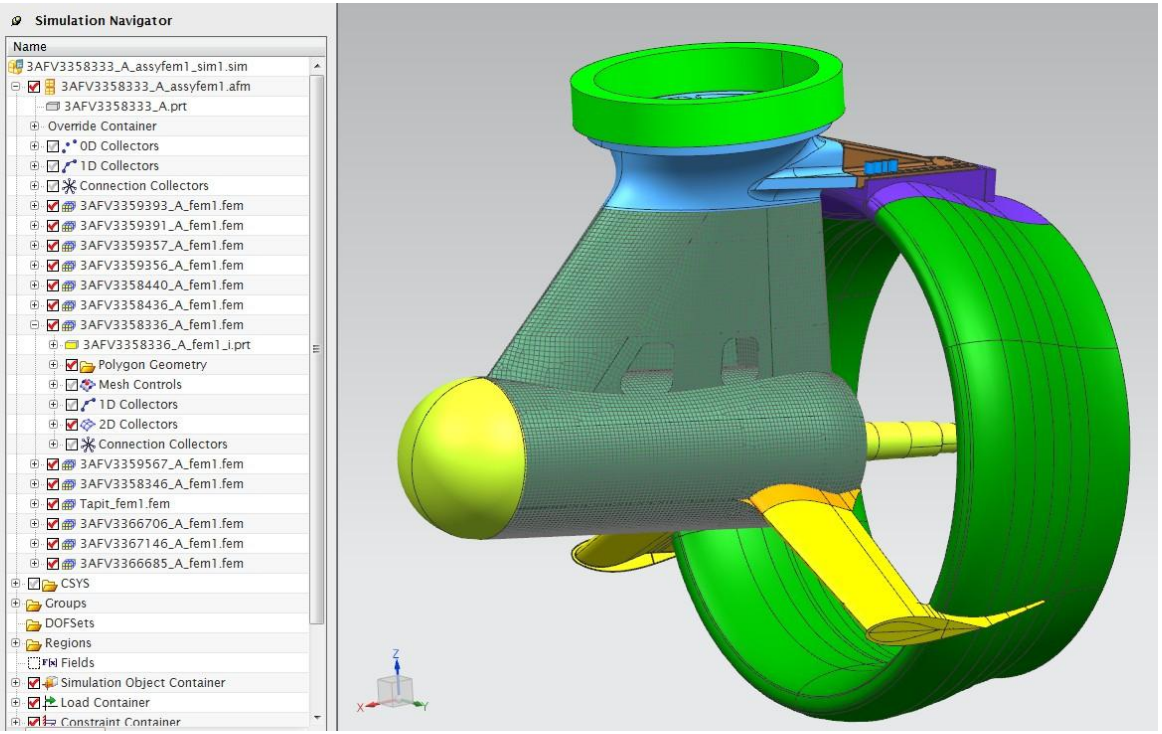
Geometry preparation

- Simulation was carried out using Simcenter™
  - FE analysis with Simcenter 3D
  - CFD calculation with STAR-CCM+
- Normally an idealized part (i-part) is created
- 3D model preparation for FE includes:
  - Removing unnecessary details
  - Stitching edges of plates together
  - Splitting the model to suitable entities (volumes and surfaces)
- Usually working on assemblies makes modifications easier than working on a model consisting of several parts joined together.



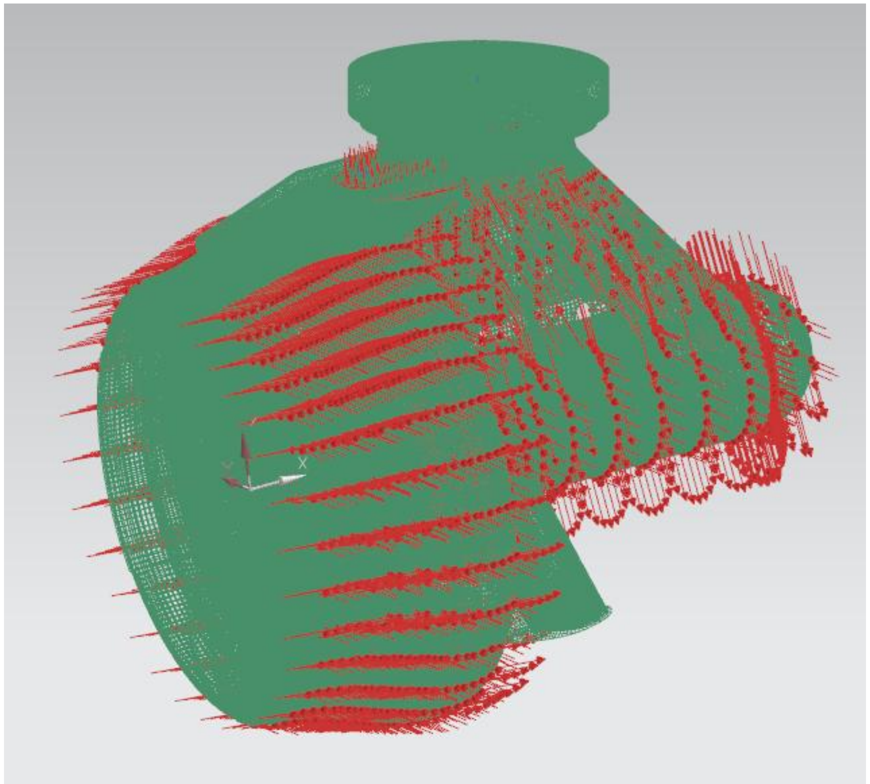
FE model structure

- Modular FE model structure based on assembly.
- Advantages:
  - Enables easy local modifications without need of extensive re-meshing of entire model
  - Possibility to combine new and existing FE models
  - Quicker analysis of design variations
  - All changes and analyses can be based on one ”master” model
  - Can be connected by various contact, matching mesh / glue etc. methods
- The illustration shows different components in colours



FE model structure

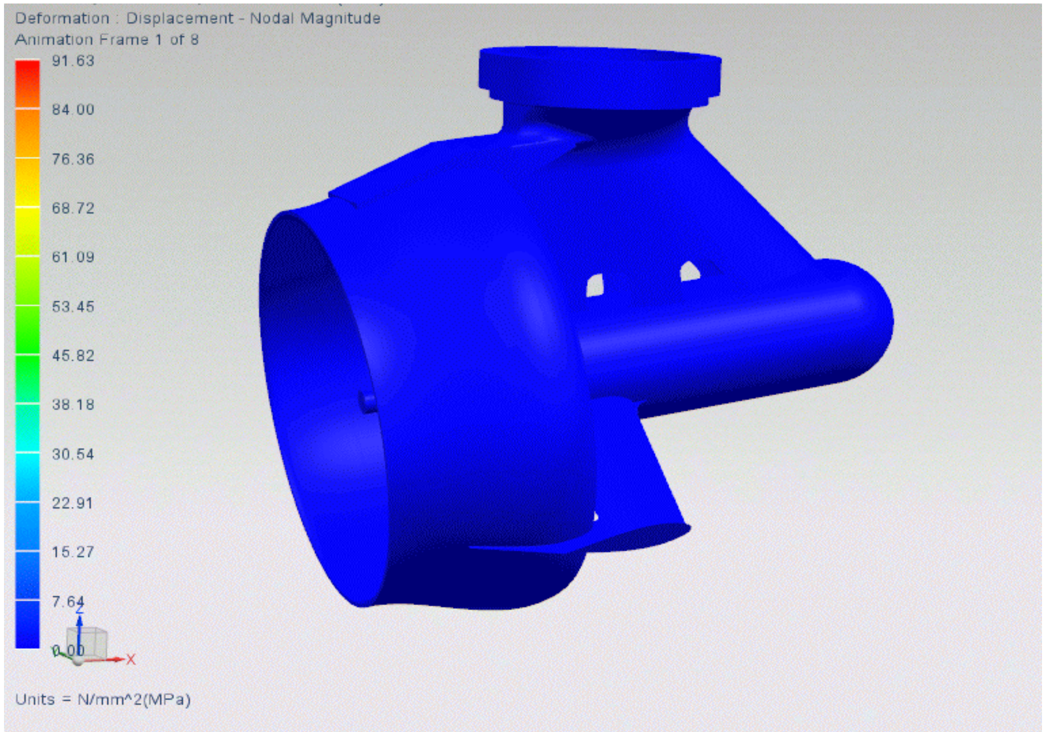
- FE meshing:
  - Plate surfaces are modeled with shell elements
  - Complex shapes with solid elements
  - Additional masses with mass elements
  - Bolts with beam elements
  - Bearings with spring elements
  - Different connection elements (bolt heads etc.)
- Loads:
  - Point loads
  - Pressure loads
  - Accelerations
- Constraints:
  - Case dependent



Structural strength

- Animations may be utilized to understand, which deformations are mainly contributing to stresses.

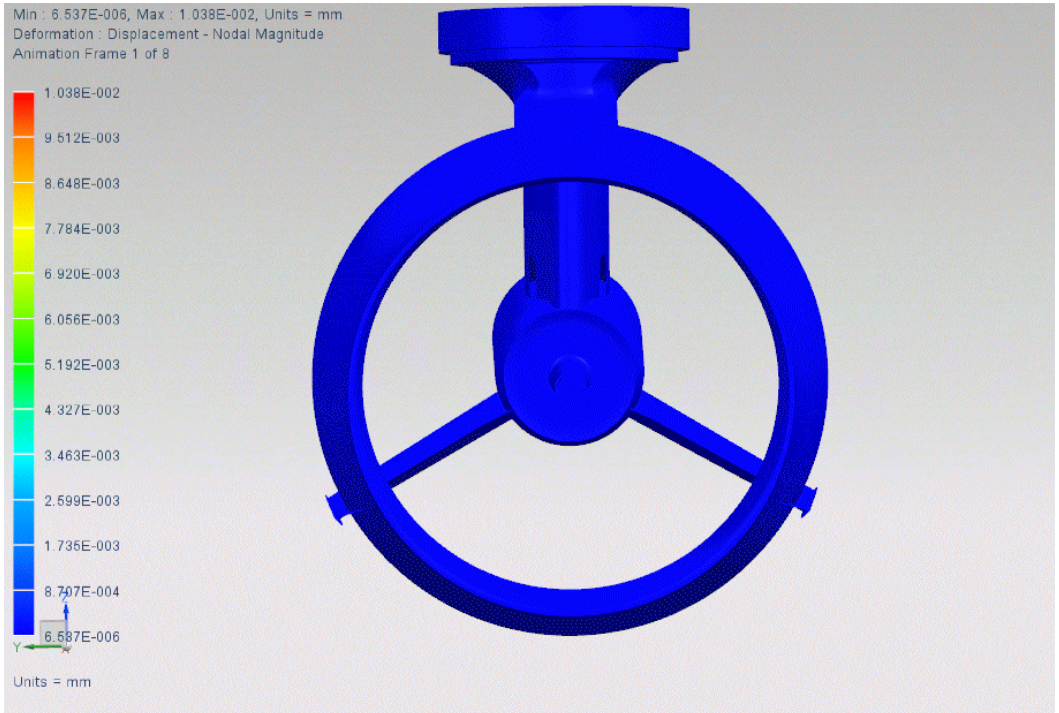
- Fatigue strength:
  - Shafts
  - Welds
  - Typically defined by
    - Analysis of nominal stresses and application of stress concentration factors
    - Or by hot-spot method



Eigenmode analysis

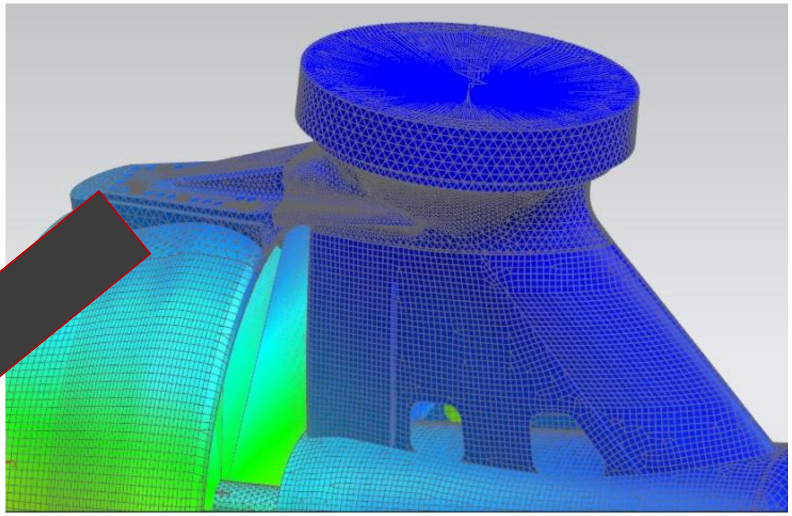
- Added mass elements are added to the structural FE model.

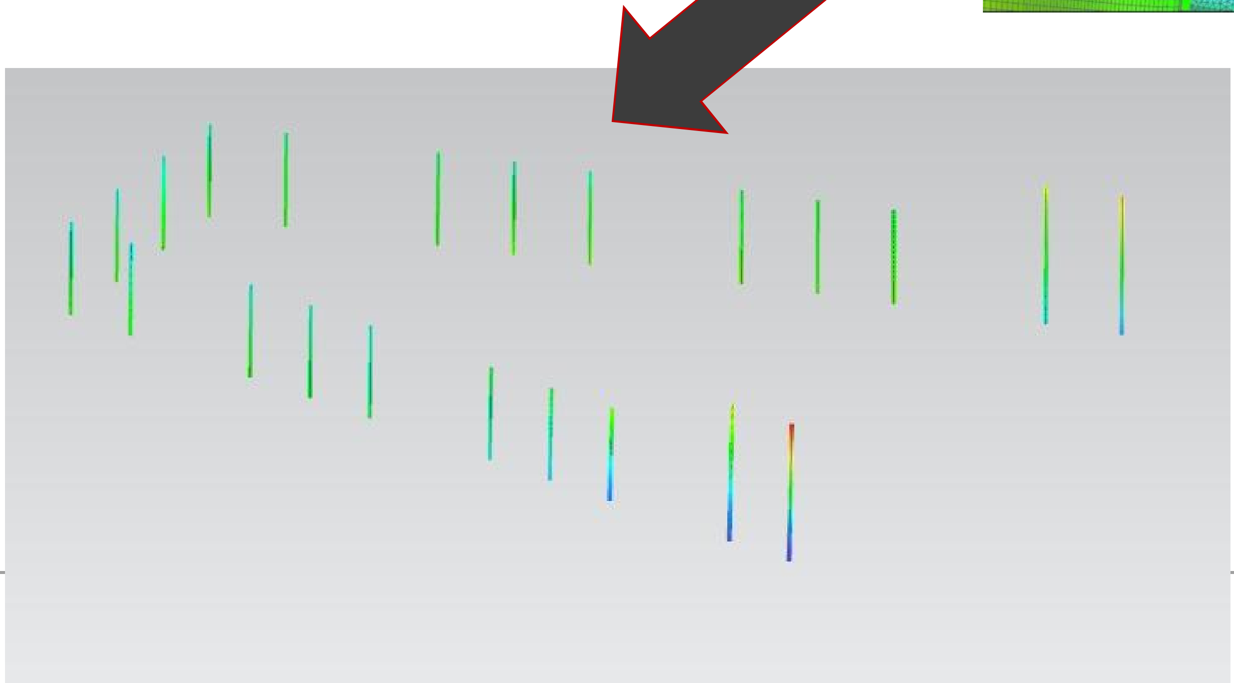
- The most typical excitation frequencies must be avoided:
  - Propeller excitations
  - Motor excitations
  - Other case dependent excitations



Linear and non linear analysis

- General structural stresses and eigenmodes are solved with linear models
- Complex bolt joints may be modeled as frictional contacts





Final documentation

- The final ”as-built” product must be analyzed and documented.
- The calculation set may include for example:
  - Shaftline analysis
  - Hull analysis
  - Propeller analysis
  - Steering module and slewing bearing analysis

Questions / comments?

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Link:
Azipod® at ABB
http://new.abb.com/marine/systems-and-solutions/electric-propulsion/azipod

Videos:
Azipod® D
https://www.youtube.com/watch?v=9Mal2ouinpo
ABB Azipod® propulsion unit assembly Timelapse
https://www.youtube.com/watch?v=lvHb4XTkC0A
ABB Azipod® Propulsion
https://www.youtube.com/watch?v=skMd8Yi6th8

Thank you for your attention!

ABB