Coastal Highway Route E39
Ship-bridge Collision Project

Yanyan Sha, Jørgen Amdahl, Ole Øiseth

Department of Marine Technology
Centre for Autonomous Marine Operations and Systems (AMOS)
Norwegian University of Science and Technology (NTNU)
What is the Costal Highway Route E39?

- Kristiansand to Trondheim
- 1100km
- 8 fjord crossings
- Travel time: 21 hours
Why should we build these bridges/tunnels?

- FERRY
  - Long travel time
  - Fixed time schedule
  - Weather dependent

- Bridge
  - Reduced travel time
  - 24/7
  - Weather independent
  - Scenery
How to build the bridges across the **wide and deep** fjords?
How to build the bridges across the **wide** and **deep** fjords?
How to build the bridges across the **wide** and **deep** fjords?
Proposed concepts

Pontoon-supported floating bridge

TLP suspension bridge

Submerged floating tunnel
Challenges

- Wave loads
- Wind loads
- Ship collision loads
Challenges

- Ship collision with bridge substructures
Challenges

- Ship collision with bridge superstructures
- Ship collision with bridge substructures
Collision accidents

Ship collision with bridge substructures

Ship collision with bridge superstructures
Design principles

Risk analysis → Collisions energy, force → Structural design
Design guidelines

Ship bow collision:
- AASHTO: \( P_s = 0.122 \sqrt{DWT \cdot V} \)
- Eurocode: \( P = V \cdot \sqrt{KM} \)

Ship forecastle collision:
- AASHTO: \( P_{BH} = R_{BH} \cdot P_s \)
Analysis methods

Collision tests

Numerical simulations

Analytical methods

\[ E = E_s + E_b \]
Our models
An example
Finite element models

Cruise ship bow

Reinforced concrete pontoon

Container ship

Bridge girder
Bow-pontoon collision

Structural deformation

Pontoon response
Bow-pontoon collision

Impact force (MN) vs. Deformation (m)

Statens vegvesen

NTNU
Bow-pontoon collision

[Graph showing force (kN) vs. crush depth (m) for container, cruise, and ice-strengthened vessels]

[Comparative images of container, cruise, and ice-strengthened vessels after collision]

Statens vegvesen
Deckhouse-girder collision
Deckhouse-girder collision

Energy

Displacement (m)

0 3 6 9 12 15

Deckhouse

Girder

Force

Displacement (m)

0 3 6 9 12 15

Impact force (MN)
Deckhouse-girder collision

- Plate thickness
- Impact height
- Stiffener thickness
- Steel grade
Our work

Future work
Thank you!

Yanyan Sha  
Postdoctoral Fellow, NTNU  
Email: yanyan.sha@ntnu.no