# Sustainable Design of Lifeboat Slipways

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# Why Slipways?

- The RNLI provides Search and Rescue cover along the coast of the UK and Ireland
- It runs 233 lifeboat stations around the UK and Ireland
- There are 3 main types of station:
  - Where there is a nearby natural harbour lifeboats lie **afloat**
  - In some cases where there is no harbour, boats are launched using a **carriage** and tractor
  - In cases where there is a large tidal range or the lifeboat has to be launched over rocks a **slipway** station is used
- There are 19 Slipway stations around the UK and 2 in Ireland

# Slipway Lifeboats

There are 3 types of slipway lifeboat used by the RNLI

## Tyne Class


Introduced in 1982, main slipway lifeboat, gradually being replaced by the Tamar

**Range:** 240 n. miles
**Speed:** 17 knot
**Weight:** 25 tonnes

## Mersey Class


Introduced in 1988, can be launched by carriage or slipway

**Range:** 140 n. miles
**Speed:** 17 knot
**Weight:** 13 tonnes

## Tamar Class


Introduced in 2005, is intended to replace the Tyne as the main RNLI slipway lifeboat

**Range:** 250 n. miles
**Speed:** 25 knot
**Weight:** 30 tonnes

# Slipway Stations

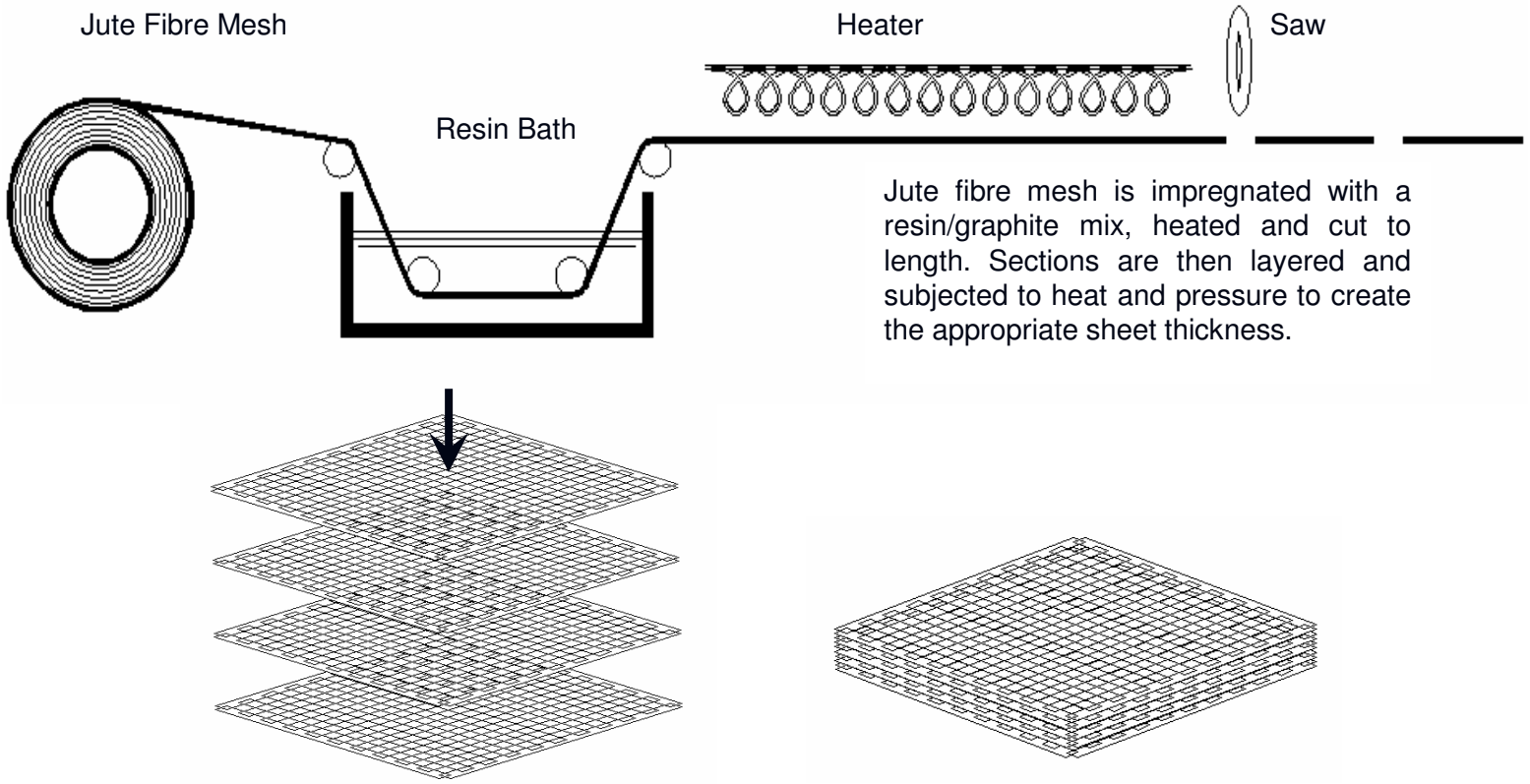
- There are many different designs of slipway stations, and a number of materials used to line the slipway
- Some slipway stations use rollers, or have a separate recovery slipway
- A variety of slipway linings are used including Greenheart treated wood, Colmonoy, Feroform composites and plain steel channels
- A variety of lubricants are also used, none, Neox grease, Lubaduk grease or running freshwater
- With the addition of the new heavier Tamar class lifeboat Feroform slipway linings have been adopted for all new boathouses

# Outline Problem

- In rough conditions it is sometimes impossible to launch lifeboats to a rescue without the aid of an inclined slipway.
- To achieve reliable slipway launch conditions lifeboats currently rely on low, controlled co-efficient of friction between lifeboat keel and the slipway channel.
- Current solutions involve using a range of low friction materials to line the keelway, and this is sometimes supplemented by manually applying grease to ensure reliable launches.
- Due to the exposed nature of the slipway and the unpredictable intervals between lifeboat launches the lubricant grease can be washed away, dry out or become contaminated with wind blown sand e.t.c. resulting in unpredictable lubrication regimes at launch and recovery.
- Currently this is apparent only as problems of high friction or even seizure occur during the launch and recovery of the lifeboat.
- Low friction composites like Feroform also experience very high wear during use.

# Feroform F21

- Feroform F21 is designed for use in marine bearing applications including marine railways (a kind of horizontal slipway) where low friction is required.
- It is made from a jute fibre/phenolic resin mix with the phenolic resin impregnated with graphite to provide lower friction.
- Feroform is used on a number of slipways and as the preferred slipway lining material for the next generation of boathouses using the new Tamar class lifeboat its use is being phased in across the remaining slipway stations



# Slipway Launching - Mersey

# Slipway Launching - Tamar

# Site Visits

- In order to investigate the wear of slipway lining materials, site visits were undertaken
- 3 Main wear types were found:

**Ploughing Wear**

Raised section on keel ploughs through the slipway lining

**Edge Wear**

Edges of Feroform sections wear

**Delamination Wear**

Jute layers separate under action of keel

# Existing Test Procedures

- Tribometers are used to predict friction in real life systems
- Slipway friction – large ship launches need predictable and constant friction along the slipway
  - Vosper Thornycroft – Inclined plane test rig used
  - Dunn, Kennedy and Tibbs, Denison T67 Reciprocating friction machine is used
  - Test is run until stable friction is reached
  - Also measured is the effectiveness of grease degraded in the tidal environment
- Reciprocating friction machines are used to model friction and wear for marine bearing materials
  - Tenmat – Feroform
  - Wall Colmonoy - Colmonoy

# Tribometers

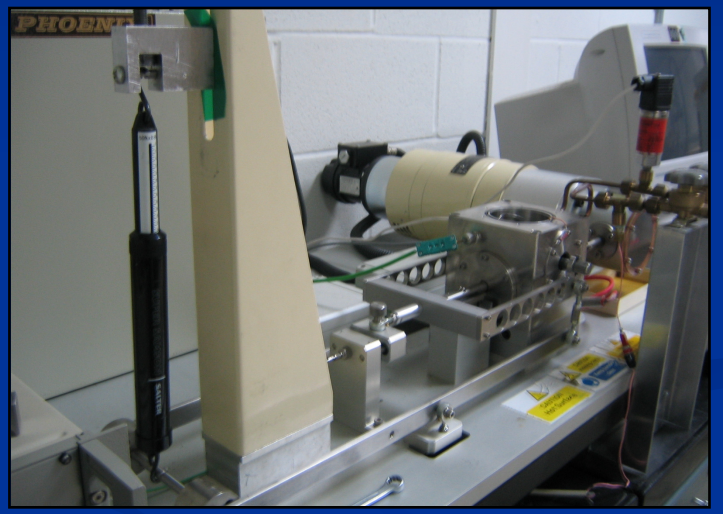
Friction and wear of slipway linings is investigated using reciprocating and rotary tribometers. Initially a TE77 reciprocating tribometer is used for screening tests and to give an initial comparison of conditions and lubricants. Later a TE92 tribometer will be used to conduct more detailed tests simulating both launch and recovery as well as more complicated environmental conditions such as wind-blown sand included in the lubricant and deposits from salt water.

**TE77 – Reciprocating Tribometer**

Used for screening tests

Used to investigate wear and friction using 3 Commonly used slipway greases, bio-greases, salt water, water and dry.

Provides quick screening tests to identify areas for investigation.




**TE92 – Rotary Tribometer**

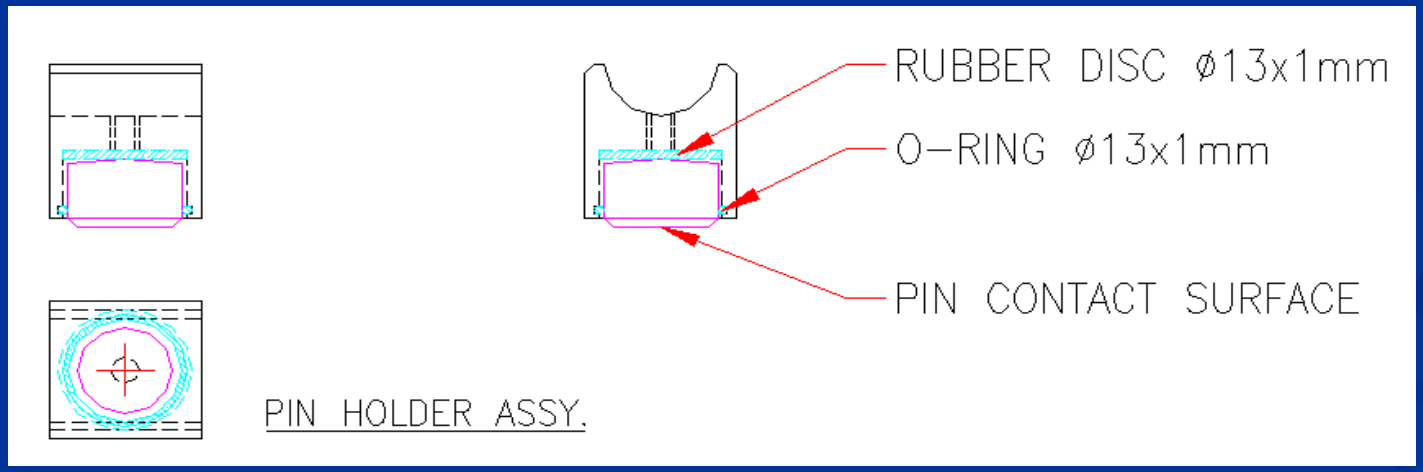
Used for more detailed friction and wear tests

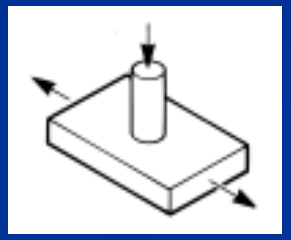
Can more accurately model real world conditions

Used to investigate all lubricants used including environmental contamination such as wind-blown sand and salt crystals. Result from both machines will be used to validate the FEA wear model to Allow the wear, friction and likely service life of slipway linings to be predicted.

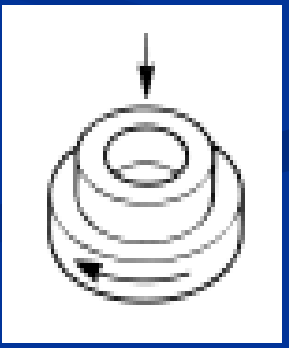
# Experimental Wear Modelling

- To simulate the friction and wear of lifeboat slipways, TE77 and TE92 tribometers are used
- TE77 is used for screening and friction tests

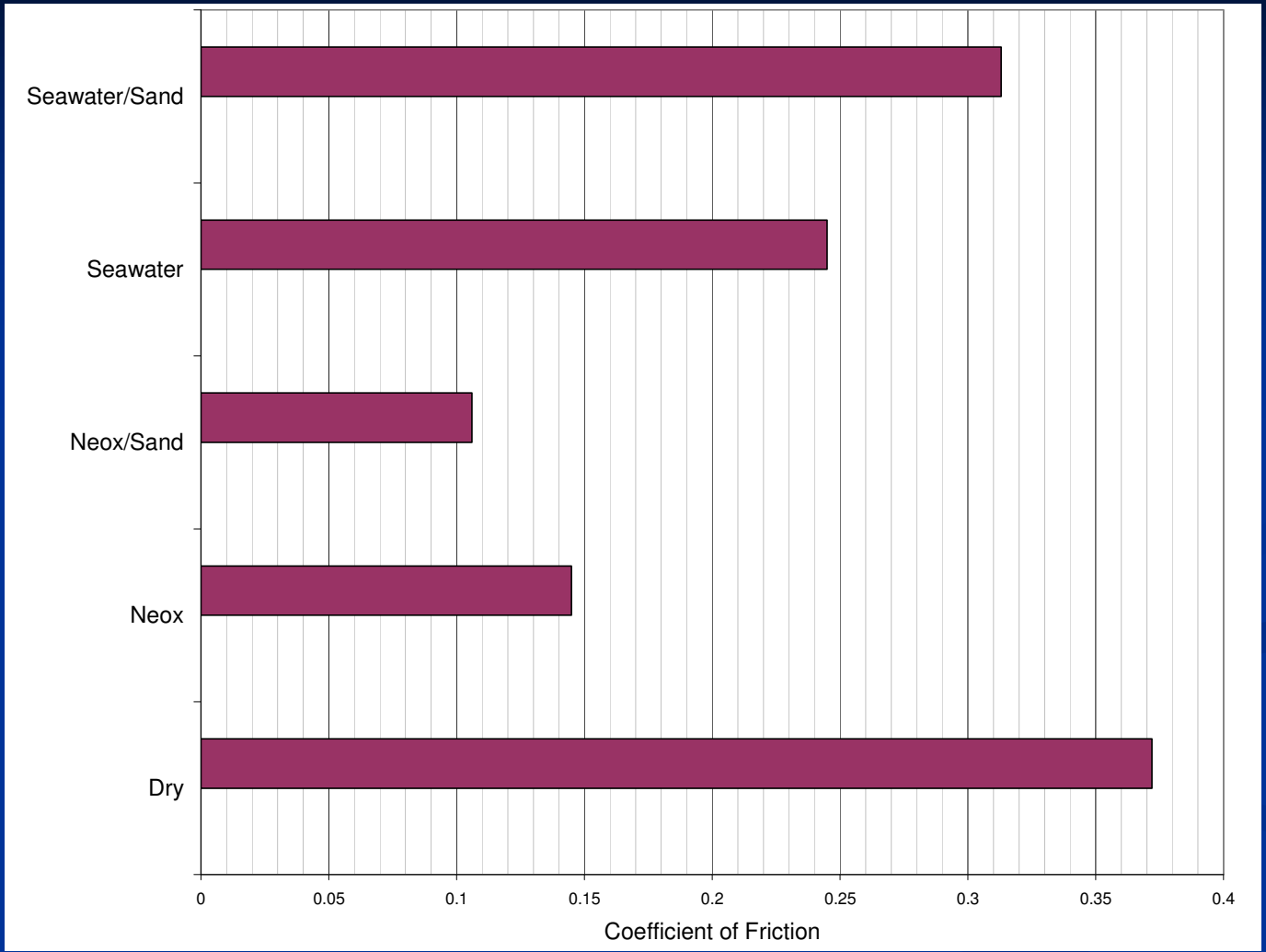


- TE92 is used for more detailed wear tests

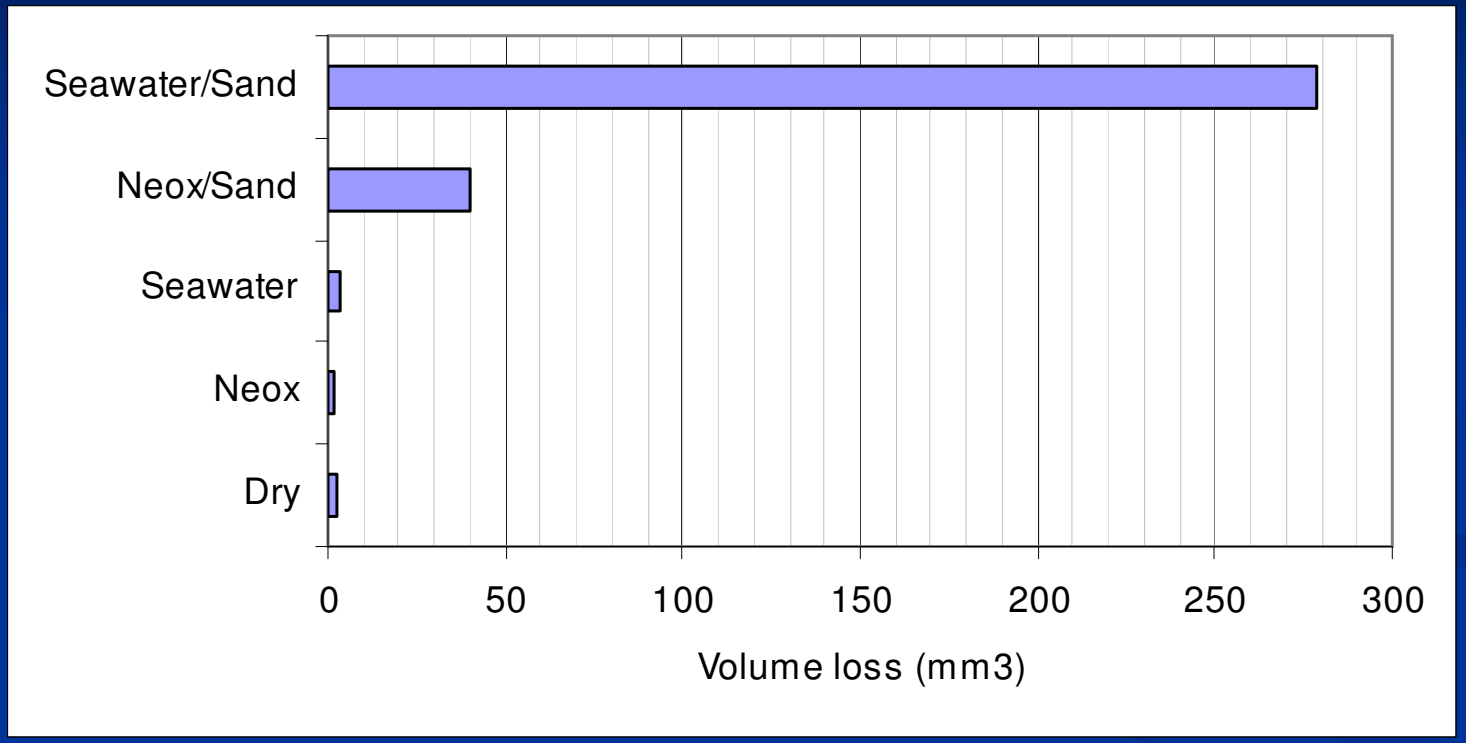


# Results - Friction




| Test ID | Dry 10Hrs | Neox 10Hrs | Seawater 10Hrs | Neox/Sand 10Hrs | Seawater/Sand 10Hrs |
|---|---|---|---|---|---|
| Coefficient of Friction | 0.372 | 0.145 | 0.245 | 0.106 | 0.313 |

# Results - Wear

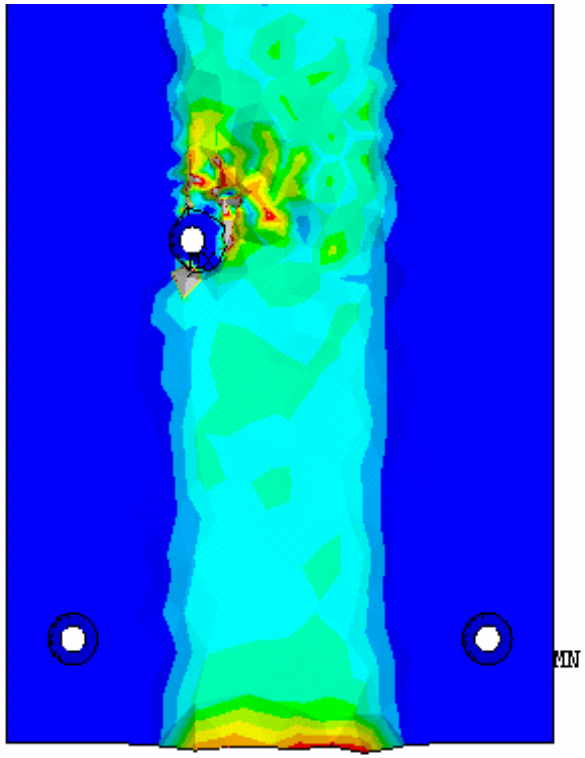


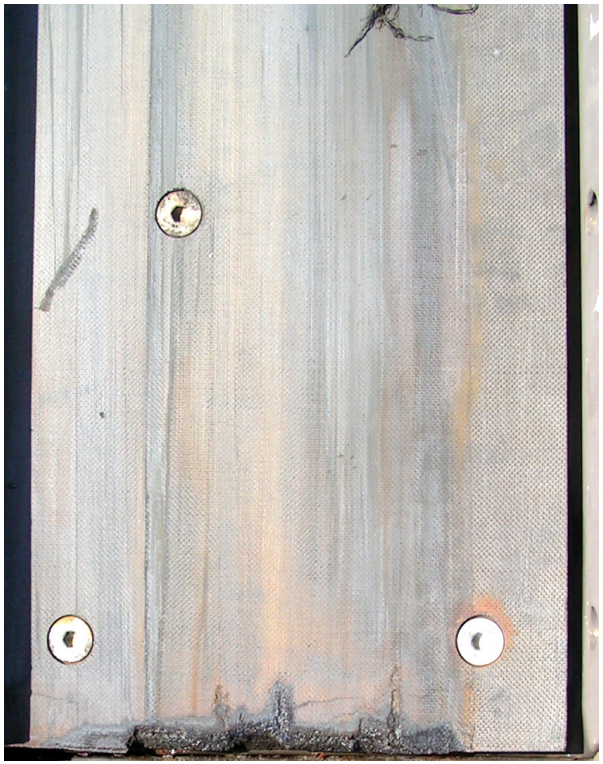

| Test ID | Dry 10Hrs | Neox 10Hrs | Seawater 10Hrs | Neox/Sand 10Hrs | Seawater/Sand 10Hrs |
|---|---|---|---|---|---|
| Sample Volume Loss ($mm^3$) | 2.640 | 1.512 | 3.419 | 40.148 | 278.844 |

# Interpreting Results (cont)

- Friction generally is higher than expected
- For a slipway angle of 11.4 degrees and a Lifeboat mass of 35 tonnes a friction coefficient higher that 0.2 will not allow the lifeboat to travel along the slipway under its own weight
- Lubricants reduce the friction coefficient but sea water alone did not provide a low enough coefficient for use
- The addition of sand to the lubricant causes very unpredictable friction and far higher wear rates
- This would imply that wind-blown sand can have a significant effect on slipway friction

# FEA Analysis





Real slipway panel wear compared with FEA simulation. Stress concentrations are present at the edge of the panel when under load from the keel and these are likely to cause the wear observed.