TALAT
Training in Aluminium Application Technologies

**TALAT Lectures 2702**

# Hoistable Deck for Ferries

9 pages, 7 figures

Basic Level

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**Objectives:**

- to describe as an example for the structural use of aluminium extrusions the design of a hoistable car deck for ferries and
- to demonstrate the advantage of the light-weight aluminium extrusion design

**Prerequisites:**

- basic knowledge of structural engineering and extrusion design
- TALAT lectures no. 1302, 1501, 2200, 2300 and 2400

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# 2702 Hoistable Deck for Ferries

## Contents



## 2702.01 Background

- Description of the hoistable deck
- Structure and material
- Design load
- Operation

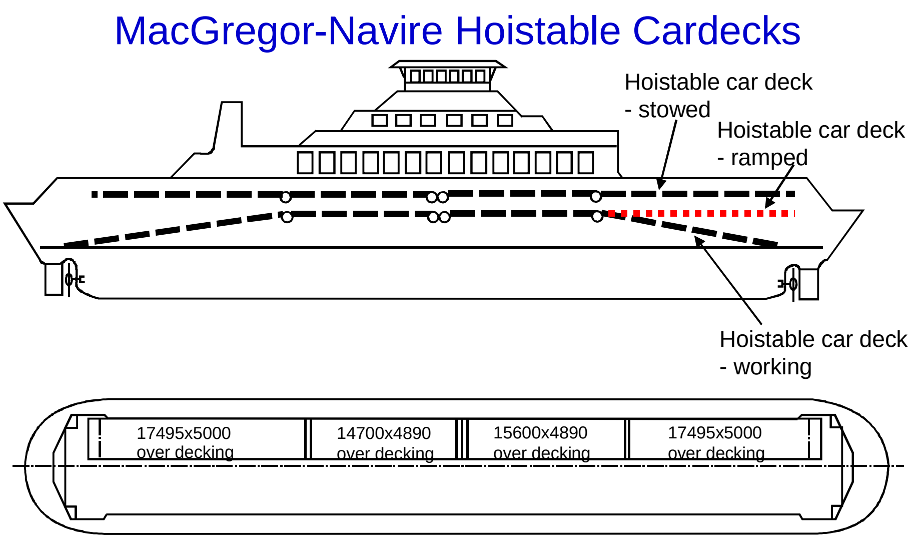
### Description of the Hoistable Deck

MacGREGOR-NAVIRE is a leading world-wide supplier of cargo handling equipment onboard ships. One of the products are hoistable decks, which can increase the extent of carried cargoes. They are being loaded in lowered position by light cargo and in hoisted position space is available for heavy cargo.

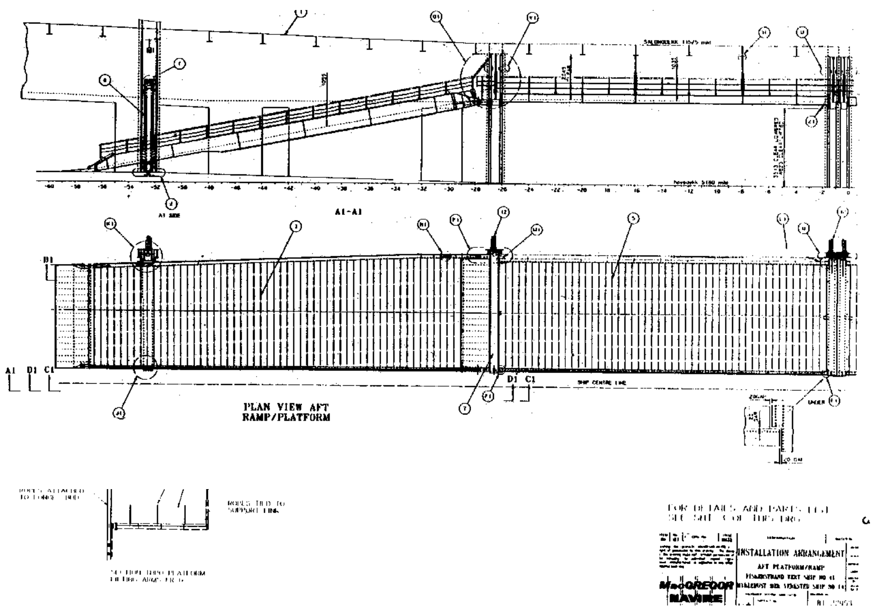
The essential objective is to achieve as low a weight as possible to allow for maximum payload in the ship. For ferries, the weight savings are also important for the stability of the vessel, the need for ballasting is reduced.
One solution chosen by MacGREGOR-NAVIRE for a delivery to three road ferries built in Norway in 1993 is to use hollow aluminium extruded profiles welded to a frame to

form deck panels. The profiles are basically developed for road bridges in Sweden. The system has been modified  and redesigned to suit another supporting method and lighter loads.

On its portside the ship is equipped with a hoistable car deck located between frames -59 and +59 between main deck and saloon deck. The deck consists of 4 ramp/deck sections, fabricated of aluminium, see **Figure 2702.01.01** and **Figure 2702.01.02**.




TALAT | Hoistable Car Deck | 2702.01.01




TALAT | Hoistable Car Deck: Installation Arrangement | 2702.01.02

The ramp sections are designed to be raised when loaded with cars. The deck sections are divided longitudinally at frame -1, which enables the forward and aft panels to be hoisted independently. The car deck has a total area of approximately 370 m².

Section sizes are:

| | |
|---|---|
| Total length | 70.8 m |
| Length of ramp | 19.2 m |
| Length of panel | 16.8/15.6 m |
| Width approx. | 5.3 m |
| Driveway | 5.0 m |
| Slope at entrance flap | 5° |
| Max. slope | 11° |

The clear deck heights are:

| | | |
|---|---|---|
| when the car deck is lowered | | |
| | above: | 2000 mm |
| | below: | 3500 mm |
| when the car deck is hoisted | | |
| | below: | 4800 mm |

**Structure and Material**

The aluminium structure is composed of two longitudinal welded beams welded to a frame. Aluminium profiles with anti-skid pattern incorporated are welded between the beams to form the driveway.

Fixed wheel deflectors are provided for the ramp sections. An automatic folding railing is fitted to the car deck and ramp sections at the free longitudinal edge. Cut-out is made for a sliding door for passenger access.

The transition flaps for the ramps are of open aluminium construction with aluminium topplate with anti-skid pattern. The lifting arms constructed as "L" are of steel welded to closed box construction.

**Design Load**

The design load to be considered is:

- Uniformly distributed load: 250 kg/m² (excluding self-weight)
- Maximum wheel load, locally: 1500 kg on a print area of 150 x 200 mm (this reflects the owners’ requirement to have extra margin for unevenly loaded cars).
- Maximum axle load generally: 1500 kg
- Weight of one car: max. 2800 kg.
- Capacity of each ramp: 8 cars during hoisting. The stowing dimension of one car is approx 4.5m x 1.8 m.

**Operation**

The hoisting of each car deck section is carried out by means of direct acting pushing cylinders located at the casing sides. The cylinders are fitted below the lift arms such that they are accessible when the car deck is in stowed position.

The aluminium car deck sections are supported during hoisting by frames of L-type, built of steel structure, running in guide channels in the casing.

In stowed position, the car deck sections are locked by means of hydraulic locking devices located in the hull. In the car deck position, the panels are supported by foldable hanging stays at the free edge and fixed supports in the hull elsewhere.

The car ramps are supported in the hinge end by the same support as the attached deck section.

In the ramps' other end separate frames of L-type, which run in guide channels at the outboard side, are arranged as support for all ramp positions, lowered, raised and stowed positions.

The ramps are connected to the L-frame on sliding supports which allow relative movement between the frame and the ramp. This is due to the fact that the ramp support performs a rotating movement and the lifting arm is running straight. The L-frames are actuated by telescopic cylinders located in the guide channels.

## 2702.02 Structural Requirements

- Choice of material
- Rules and regulations
- Structural principle
- Calculations

### Choice of Material

The decks were specified by the owner to be of aluminium due a number of reasons:

1. Less maintenance due to the non-corrosive nature of the material and no need for painting
2. Increased stability of the vessel
3. Lower lifting forces and thus smaller installed power unit

The material used for the main beams and plates is AlMgSi1-T6 or AlMg4, for extruded hollow profiles AlMgSi 0,5-T6.

### Rules and Regulations

The decks are designed and calculated according to the rules of Det Norske Veritas, (DNV) and to their approval.

The rules specify stress limits from static loads multiplied by a dynamic magnification factor.

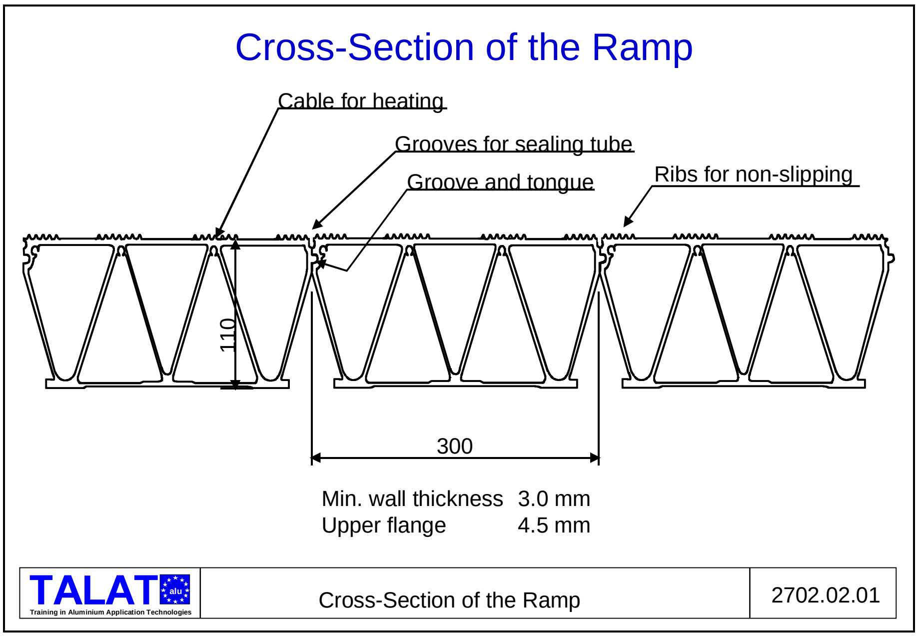
The dynamic factor is calculated from the ship's motion at sea under stormy conditions.

The fabricated structure and the material are also to be tested and checked by DNV.

Finally, a load test is carried out on the complete ramps and decks in the ship to check the ramp as a lifting gear.

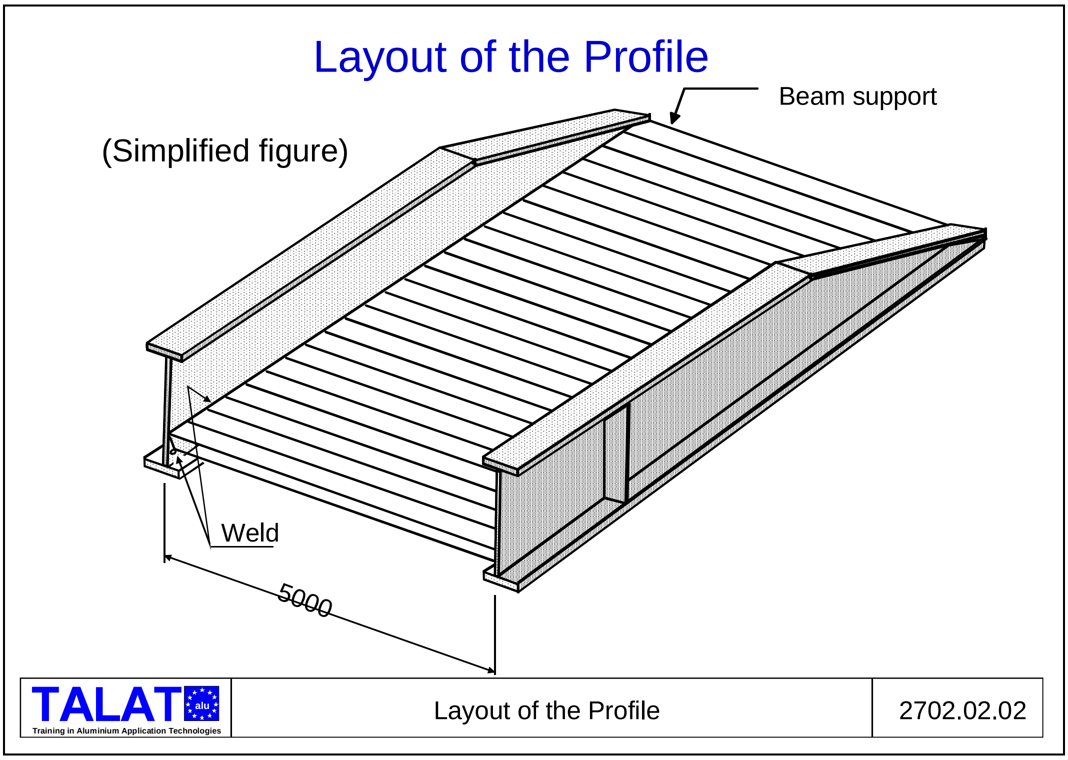
### Structural Principle

In principle, the panels are composed of two basic elements: longitudinal welded girders which carry the overall load and transverse extruded profiles connected to the longitudinal girders by welding (see **Figure 2702.02.01** for cross-section of the ramp).




The extruded profile design is choosen rather than the welded plate and stiffener style because the extruded profiles are easier to assemble during the fabrication process which results in lower costs; furthermore, certain features such as anti-slip grooves and holes for heating cables can be incorporated in the profiles. The profiles are connected to each other by the tongue and groove method. To prevent water drip through the deck the joint is sealed by mastic filled in the groove between the profiles.

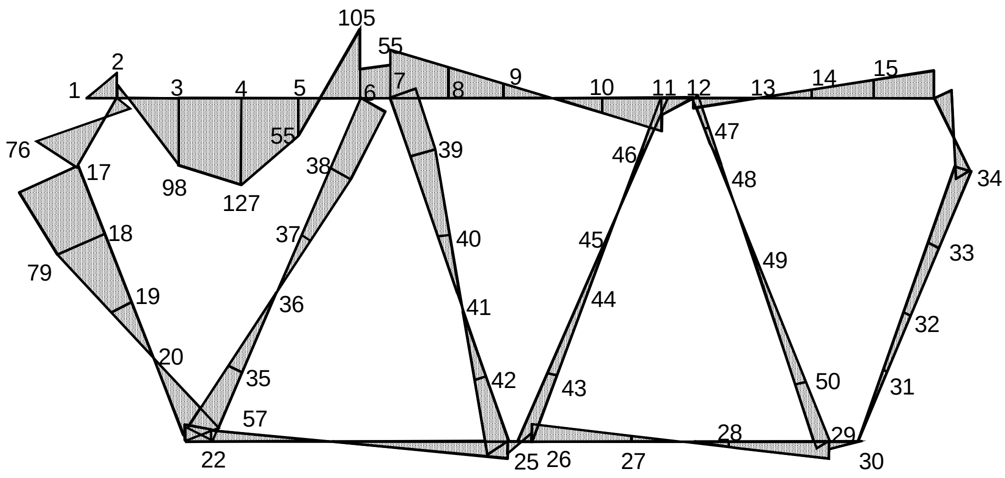
Note that the driving surface is not covered with any road-way surface material (see **Figure 2702.02.02**).



## Calculations

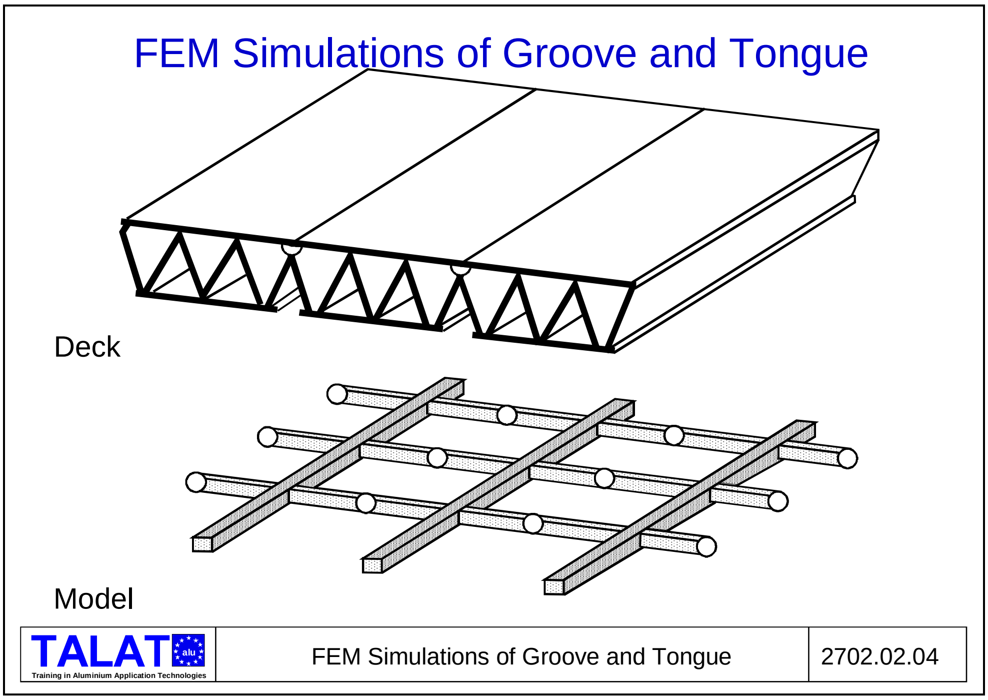
The structure is designed by ordinary FEM-methods. One model with plate elements is used for the profile itself to check local stresses (see the example in **Figure 2702.02.03)**.

Local Bending Stresses in the Profile

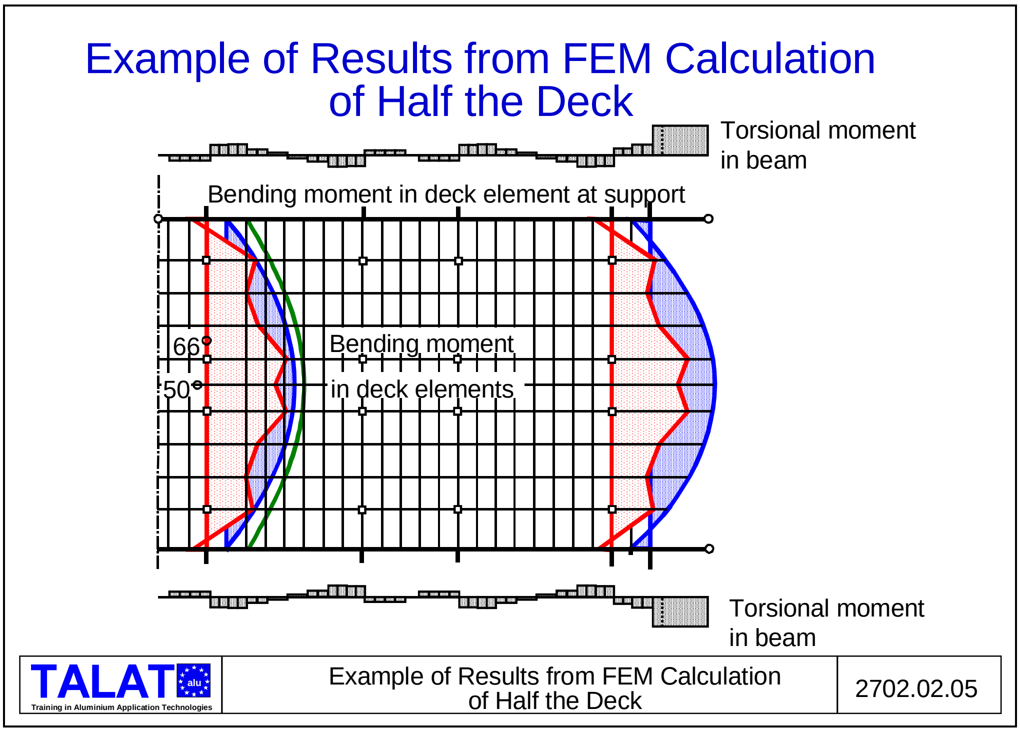



TALAT Training in Aluminium Application Technologies | Local Bending Stresses in the Profile | 2702.02.03

Another model consisting of beam elements is used to check the overall load distribution and the welds for the attachment between profiles and girders. The deck elements are simulated by beam elements with short transverse elements with a hinge simulating the groove and tongue (**Figure 2702.02.04**).




An example for the output is shown in **Figure 2702.02.05**. As can be seen the hollow element has a remarkable ability to distribute the wheel loads on several elements.




The maximum span for the longitudinal girders is approximately 15,0 m and for the extrusions the span is about 5,0 m.

For further reference see the lecture on road bridges in Sweden (**TALAT Lecture 2701).**

## 2702.03 Conclusions

Similar systems have been in service in Norway for several years, no significant signs of wear and tear have appeared.

Despite of some minor disadvantages such that the design is limited by elastic deflection (which means that allowable stress levels cannot be fully utilized) and that repair of damaged elements is difficult due to the fact that welding is prohibited in high stress areas, the described system has proved to be superior if all aspects are taken into consideration:

- Low weight
- Simple design
- Simple assembly and fabrication
- Minor maintenance work
- Structural rigidity of the decking profiles

## 2702.04 List of Figures