Investigation into the Sinking of the Ro-Ro Passenger Ferry *EXPRESS SAMINA*

Reference:


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Presentation Outline

- The accident
- Investigation set up
- Investigation analysis
- Conclusions and recommendations
## SHIP PARTICULARS

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship Name</td>
<td>EXPRESS SAMINA</td>
</tr>
<tr>
<td>Ship Type</td>
<td>Passenger / Car Ferry</td>
</tr>
<tr>
<td>Builders</td>
<td>CHANTIERS DE L' ATLANTIQUE - St. NAZAIRE</td>
</tr>
<tr>
<td>Date of Built</td>
<td>01/01/1966</td>
</tr>
<tr>
<td>Area of Operation</td>
<td>AEGEAN SEA</td>
</tr>
<tr>
<td>Type of Trip</td>
<td>Day / Night</td>
</tr>
<tr>
<td>Length over all, [m]</td>
<td>115</td>
</tr>
<tr>
<td>Breadth moulded, [m]</td>
<td>18.1</td>
</tr>
<tr>
<td>Depth to the upper deck, [m]</td>
<td>10.7</td>
</tr>
<tr>
<td>Depth to the main deck, [m]</td>
<td>6.01</td>
</tr>
<tr>
<td>Subdivision Draught, [m]</td>
<td>4.55</td>
</tr>
<tr>
<td>Service Speed, [kn]</td>
<td>18.0</td>
</tr>
<tr>
<td>Gross Register Tonnes</td>
<td>4407</td>
</tr>
<tr>
<td>Deadweight, in tonnes</td>
<td>1089</td>
</tr>
<tr>
<td>Passengers according to summer certificate</td>
<td>1038</td>
</tr>
<tr>
<td>Passengers according to winter certificate</td>
<td>335</td>
</tr>
<tr>
<td>Number of persons in Boats</td>
<td>674</td>
</tr>
<tr>
<td>Number of crew</td>
<td>62</td>
</tr>
</tbody>
</table>

Compliance with the provisions of EUROSOLAS regulatory framework, disposing an A/Amax over 0.98, according to MSC/ Circ. 574 & Circ. 649 for one compartment standard.
The Accident

- Accident time: Tuesday September 26, 2000, 22:10 local time
- The ship: passenger/Ro-Ro ferry EXPRESS SAMINA
- Trip conditions: Average speed of 18.5 knots and moderate weather conditions of 5-6 Bf
- People onboard: 533 people onboard, 472 passengers and 61 crewmembers
- Cargo payload: 17 trucks and 34 cars on car deck
- Approaching the port of the Greek island Paros, she collides with the rocky islet Portes, at a distance 3 nm from the destination port
- The ship sank after abt. half an hour as the result of flooding of the main engine room and further progressive flooding of the entire buoyant spaces
- The accident caused the loss of 80 people
The Accident
The Damage Openings

- Damage ‘A’: due to stabilizer fin penetration, abt. 3,00 m long
- Damage ‘B’: set of three openings (raking cracks) with the longest one 0,60 m
- Damage ‘C’: raking damage above WL, more than 6,00m long
- Damage ‘D’: cracks of secondary importance
The Main Damage Opening at E.R.

- The crucial underwater damage ‘A’ due to the penetration of the right stabilizer fin into the main engine room (one compartment damage)
Accident’s events reconstruction was based on the systematic analysis and matching between the information obtained from survivors’ testimonies and divers’ findings, the performed hydrostatic calculations and finally the numerical time domain simulation of ship’s foundering.

In this way, the most probable scenario was identified as the scenario that matched best the information and facts in hand and also satisfied the conditions resulting from the numerical tools simulation.
Testimonies Analysis

- One hundred and ninety two (192) testimonies of surviving passengers and seventy-five (75) testimonies of crew (from whom twenty-nine (29) testified more than once) were captured in a developed database and systematically analyzed.
Testimonies Analysis –
Time of Collision and Foundering

Average Time of Accident = 22:10 (Sample 92 passengers)
Average Time of Sinking = 22:42 (Sample 43 passengers)
How passengers got life jackets

- From other passenger: 28%
- From crew: 8%
- Never got: 2%
- On his own: 62%

Sample of 181 passengers
The Hydrostatic Damage Stability Analysis

3 Possible Damage Scenarios

- The ship proved satisfactory in terms of reserve buoyancy and relevant stability criteria to withstand the particular (as other) one compartment flooding.

- It proved that for the particular loading condition that the ship could survive this two compartment damage as well.

- For the indicated 3 compartment damage, the bulkhead deck line immerses at the equilibrium position, however the ship would have adequate reserve buoyancy and stability as well as adequate margin of heel to avoid an immersion of the damage opening located at platform deck. She would float at least for a prolonged time to allow safe evacuation.
The Watertight Doors

- The found most probable scenario considers 9 out of 10 watertight doors open. This scenario is practically also confirmed by the testimonies and divers findings.
Investigation analysis employed the *CAPSIM* time domain numerical simulation code of NTUA-SDL for the damaged ship motion and flooding simulation.

In particular it was possible

- To simulate the flooding process of the damaged compartments and the subsequent progressive flooding

and

- To estimate the sequence of a series of characteristic events that took place during the ship’s sinking and are of importance for the legal process.
**Simulation method** calculates the nonlinear 6 DOF motion of an (intact or) damaged ship in time domain under the excitation of external forces (gravity, sea waves, wind etc) and of internal interaction effects due to floodwater.

- **Ship to wave** hydrodynamic interaction is treated within linear potential theory (panel code NEWDRIFT).
- **Ship to floodwater** interaction is treated by a simplified formulation of the coupling forces.

**CAPSIM Code**

3D non-linear time domain code for the 6 DOF ship motion at zero speed of intact or damaged ship in regular and irregular seaways, considering variable flooded water (inflow-outflow hydraulic model)

Computing time at ALPHA WS 1:4 (to real simulation)

RAM requirement < 10 Mb

**NEWDRIFT Code**

Seakeeping code based on 3D panel method (pulsating source) - 6 DOF

Linear and quasi-nonlinear frequency domain analysis (drift force effects included)

Regular waves excitation – irregular seaways through spectral analysis procedure

**Intact vessel**
Geometric Modeling

- Damage openings, Doors, Staircases, Ventilation openings, etc. are geometrically modeled permitting the simulation of water flow through them.

- Spacious objects, like main engines and generators, were modeled as 3D geometric spaces.
The Estimated Heeling Scenario

- Comments on characteristic stages of ship’s sinking

![Graph showing estimated heeling scenario with time and heeling degrees]
Progressive Flooding of Spaces

- Water pours into the main engine room through damage opening A and flows through the open left watertight doors into the entire ship.
- Through the numerical simulation, the time series of water elevation in every compartment is obtained, enabling the estimation of the time during which the particular compartment was accessible or not by people onboard.
Sea Waves Effects

- Prevailing weather conditions during the ship’s sinking were moderate up to 6 Bf with a significant wave height 1.5-2.0 m.
- Numerical simulation proved that wave effects have limited effect on the events evolution with the main effect arising at the later stages of flooding.

![Graph showing heeling in seaway and still water with time in seconds](image)
Sea Waves Effects

- Evolution of free surface of floodwater inside the E.R.

![Graph showing floodwater free surface into E.R. below still water plane over time.](image-url)
Alternative scenarios considering watertight doors closed were also investigated and proved that ship would have survived in these cases or would have behaved in different way.

![Graph showing heeling in still water and scenario of three compartments flooded.](image-url)
The ship wreck was found 1.4 nm away from the collision spot, just 0.3 nm away from the island’s coastline.
Conclusions

- The passenger/Ro-Ro ferry *EXPRESS SAMINA* sank after collision with a rocky islet due to the lack of watertight subdivision resulting from the fact that the water tight doors were left open.
  
  - *Ship watertight subdivision should be recorded and be controllable at any time*

- The employment of a time domain simulation method in the investigation of the ship’s loss proved particularly useful, enabling the reconstruction of history and the estimation of the events’ sequence independently of the quality of available testimonies of survivors.

- Ship evacuation studies, considering the time of a ship to sink, should exploit modern analysis tools to rationalize and improve the evacuation procedures, minimizing the risk of loss of lives. An increased research effort in this field appears advisable.

  - *Time to sink and stability during the flooding process are two significant parameters that need further investigation*
The Sinking Scenario

The collision on the rocks at 22:10 (+0 min)
The Sinking Scenario

The transient heeling of 5 deg at 22:13 (+3 min)
The Sinking Scenario

Immersion of upper damage opening at 22:23 (+13 min)
The Sinking Scenario

Immersion of promenade deck, heeling 23 deg, at 22:27 (+17 min)
The Sinking Scenario

Immersion of embarkation deck, heeling 33 deg, at 22:30 (+20 min)
THANK YOU VERY MUCH FOR YOUR KIND ATTENTION

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