

Costa Concordia Salvage Operation

Italy

Project Facts

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| Industry | Marine Salvage |
| Region | Europe |
| Services | Fabric Formwork |
| Project year | 2012-2013 |
| Operator | Costa Crociere |
| Contractor | Titan Micoperi |
| Water depth | 30-40 meters |

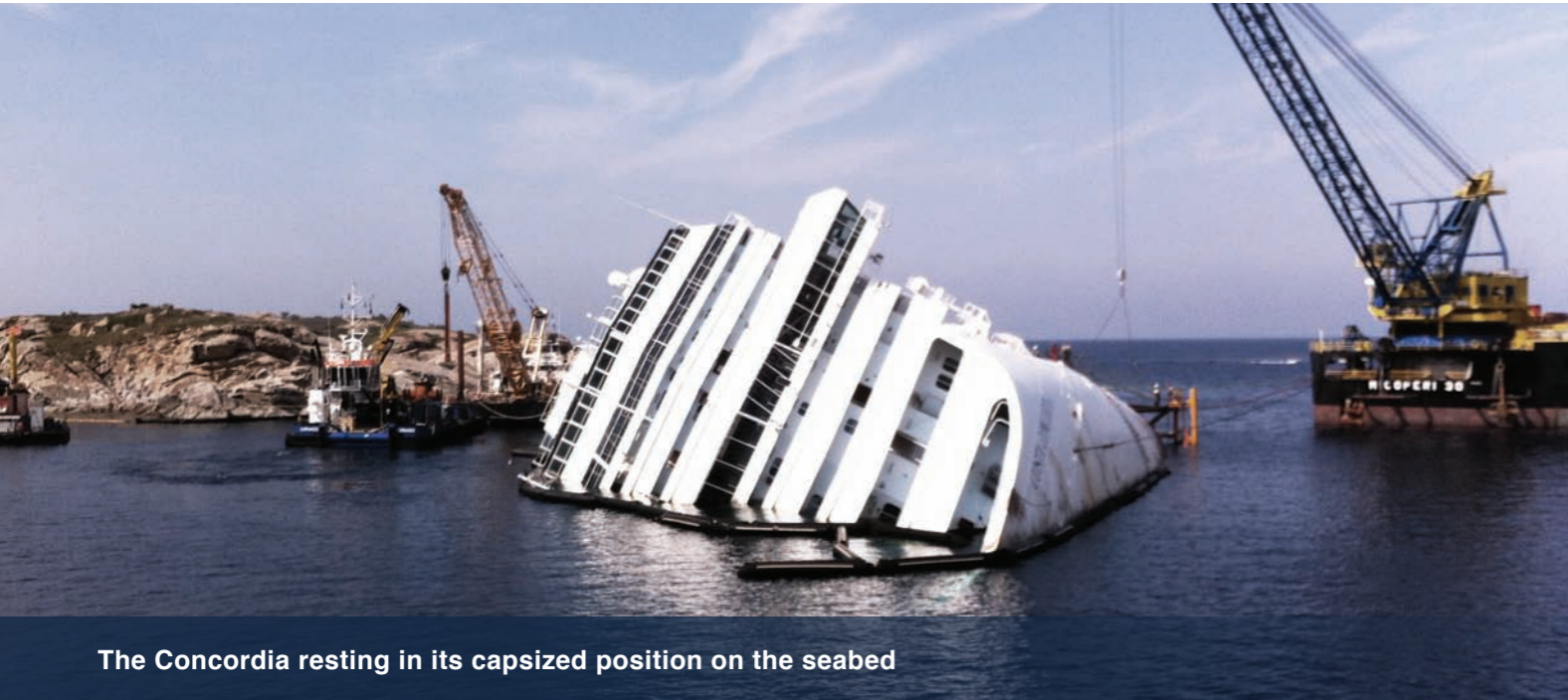
Case Study



Introduction

In January 2012, tragedy struck the Costa Concordia cruise ship as it ran upon rocks off the western coast of Italy in Isola di Giglio, causing the ship to list to its side, and resulting in the loss of 32 lives.

The ship currently rests on the seabed in its capsized position, at a depth of approximately 30m.



The Concordia resting in its capsized position on the seabed

The Project

To safely remove the ship, the salvage plan involves first securing and stabilizing the wreck, using anchor blocks attached to the seabed. This is to prevent the ship from slipping along the steep incline of the seabed into deeper water.

The next step is preparing a false flat bottom using a combination of piled platforms and grout-filled fabric formworks, on which the wreck will rest after it has been rotated to an upright position (parbuckling).

Airtight tanks, or sponsons, will be attached to either side of the hull to help with the parbuckling and refloating operations.

Once the parbuckling and refloating is complete, the ship will be towed away to be dismantled.

It is estimated that this exercise will use approximately 20,000 tonnes (18,000m³) of cement.

Ambico FoundOcean was awarded the scope to supply and install approximately 2,000 custom designed fabric formwork grout bags and grout mattresses.

The grout-filled formworks are required to act as a false seabed which takes the ship's load once the parbuckling is complete.

Wall of formworks

In order to construct an artificial seabed to create a stable base for the hull, a construct of grout bags will be placed to occupy the empty space between the two spurs of rock (one in the stern area and the other in the bow of the hull – some 90m apart) on which the wreck is resting.

Fabric mattresses measuring seven meters by four meters will be laid on top of the wall of formworks and subsequently filled with grout to provide an even surface onto which the ship will be rolled. This will ensure that the weight of the ship's hull is evenly distributed so as not to create stress points that could damage the hull.

Formwork Design

Ambico FoundOcean has designed and is manufacturing the grout bags in its manufacturing facility in Navi Mumbai according to the ongoing project requirements. They are made from a flexible, high-strength synthetic woven fabric which is permeable to water but not to grout. The wedge-shaped bags are designed with sturdy partitions so that they fill evenly to produce a stable formwork.

Eight different types of grout bags have been designed for this job ranging in size and shape, weighing up to 100kg in air before filling. The large rectangular formworks are seven meters long, three meters wide and two meters high, with a 42 m³ grout volume and weigh approximately 55 tonnes when filled. Smaller wedge-shaped bags are also being used: these are 3.5 meters long and have an 8.1 m³ grout volume and weigh 10 tonnes when filled.

Various other shapes and sizes have been designed to account for the variable topography of the seabed, and to accommodate the huge parbuckling chains which will be laid on top of the formwork-bed.

Ecosystem Safeguard

In order to meet the environmental requirements of the salvage project, the seabed must be returned to its original condition.

The Ambico FoundOcean fabric formworks, which weigh up to 50 tonnes each when filled, have been designed to be lifted out of the sea when the salvage operation is complete. They will then be taken ashore for processing and recycling.

Grouting Procedure

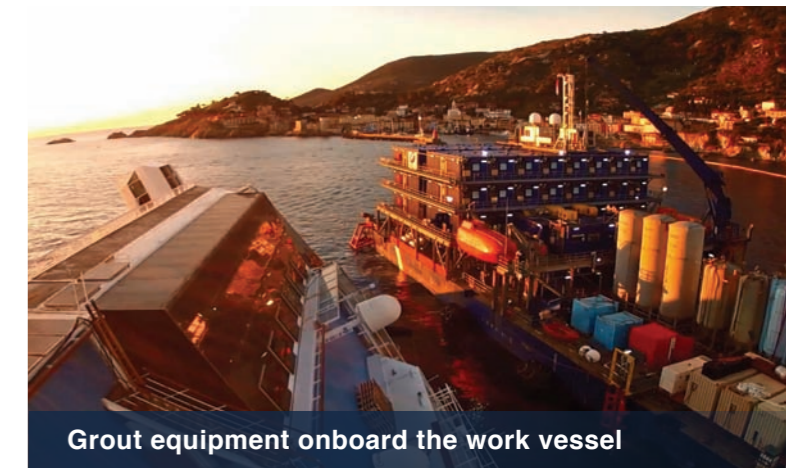
The shallow water depth allows the formworks to be installed by divers, who will connect the hoses to the fabric bags to fill them with grout.

Once the formwork construct is complete, grout mattresses will be placed over them. These mattresses are being manufactured using the same high-quality fabric as the formworks, and will provide a flat and stable base for the ship to rest on once it has been pulled upright.

Mixing System

Cement is stored in multi-tonne vertical silos, and is mixed on deck using a FoundOcean Recirculating Jet Mixer (RJM).

Grout samples are taken from the mixer, which set as grout cubes in a curing tank. This is to demonstrate that the compressive strength of the grout meets the requirement for the project.



Grout equipment onboard the work vessel

When built in 2005, the Concordia was to be the largest Italian cruise ship, measuring 951m in length and weighing over 114,000 in gross tonnage.

Contact Us

#701-702 Shri Sai Corporate Park, Next to Polaris Tower,
Opp. Laxmi Nagar Industrial Estate, Goregaon Link Rd.,
Goregaon (West), Mumbai – 400 090, India.

Tel: +91 22 2876 6641 / 42
Fax: +91 22 2876 9473
Email: info@ambicoindia.com

www.ambicofoundocean.com

