Accidental Ice Management – Platform vs. Ice Breaking Supply Vessel Collision

Martin Storheim
SAMCOT – Center for Sustainable Arctic Marine and Coastal Technology
Department of Marine Technology, Norwegian University of Science and Technology, Trondheim, Norway

Jørgen Amdahl
AMOS – Center for Autonomous Marine Operations and Systems
Department of Marine Technology, Norwegian University of Science and Technology, Trondheim, Norway

ABSTRACT
Due to the prospects of large oil and gas reservoirs in the Arctic, there is a continuous demand for semi-submersible drilling rigs for operation in the ice free season of the year. Preferably the drilling rigs will have a sufficient ice class to endure possible ice encounters without hazard to environment or crew.

Due to the high demand for drilling rigs worldwide and the large costs associated with upgrading existing rigs for ice regions, rig owners tend to use rigs without ice reinforcement, assuming sufficient support from ice management vessels can be provided. It is reasonable to assume that the supply and service vessels operating around a non-reinforced platform in the Arctic summer conditions are reinforced for light ice conditions.

A drilling rig is usually required to withstand an impact with a 5000 ton supply vessel drifting at 2 m/s into the unit, as described in e.g. NORSOK-N004. This code covers only non-ice-reinforced supply vessels without bulbous bows. Thus, operation of a conventional drilling rig in the Arctic could include an additional safety hazard as the relative strength between an impacting supply vessel and a drilling rig is changed in favor of the supply vessel.

In a similar way, vessels with ice reinforcement may often be used outside of the Arctic regions depending on market demand. Damage to the rig in a collision is thus often underestimated, both in and outside of the Arctic regions.

This paper assesses this accidental load scenario by investigating impacts between a typical semi-submersible drilling rig and ice strengthened supply vessels. Based on the structural designs considered in this work, it is found that the potential damage to the drilling rig in a given collision event is significantly increased if the impacting vessel has ice strengthening. Consequently, this should be considered thoroughly in the risk assessment for platform operation.

INTRODUCTION
When designing a floating offshore platform, it is often required to assess the collision resistance of the platform against a ship impact. As this is an accidental event outside of the expected 100 year return period ULS loads, significant damage to the platform and vessel can be allowed provided that the damage does not lead to progressive collapse of the structures or prevents safe evacuation.

The rules typically require the platform to resist to impact with a drifting supply vessel with a displacement of 5000 tons and a speed of 2 m/s, ref. NORSOK N-004. Recent collision events on the Norwegian Continental Shelf indicate that the 2 m/s requirement might be too low, see Kvitrud (2011). The size of the vessels used on the Norwegian Shelf has increased significantly to 7500 - 10000 tons displacement, but this size is not currently reflected in the NORSOK code. This was recognized by Hong, Amdahl and Wang (2009) who analyzed collision between a supply vessel with bulbous bow and the side of an FPSO. They found that the side of the FPSO was vulnerable to penetration by the bulbous bow. It was proposed that the side be designed to resist force intensities (pressures) that varied with the size of the contact area similar to ice pressure loads. Similarly, a pressure-area curve for supply vessel stern impacts was proposed by Tavakoli et. al, (2007).

In a collision event, it is customary to assess the external and internal mechanics of the interaction separately. The external mechanics refers to the global motion of the impacting bodies, described by mass, added mass and velocity before and after impact. The internal mechanics refers to the energy absorption in the impacting bodies by plastic strain and fracture.

A reasonable design philosophy is to allow both impacting bodies to deform, and thus energy to be dissipated in the two bodies based on their relative strength. A strong platform will lead to large energy absorption in the impacting vessel. This method leaves the platform designer to choose a relevant