

Advanced Design Methodologies for SCRs

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ABSTRACT

As the offshore industry continues to progress developments in deep and ultra-deep water locations, in many large EPCI (Engineering, Procurement, construction and Installation) contracts the considered or preferred riser system solutions are steel catenary risers (SCRs) or lazy wave SCRs.

Riser system engineering often requires the adoption of advanced procedures and methodologies in order to fit project schedule, more particularly to manage critical uncertainties and interfaces, facilitate long-lead procurement items and any qualification programs. To cope with the critical schedule and techno-economic constraints, the Saipem EPCI execution experience has necessitated the development of a fully integrated approach to riser technology and phased riser design procedure. The design procedure utilises early screening and principle of design margins, together with focused advanced design methodologies/tools to confirm key riser response when the design process is sufficiently mature. For the design of SCRs in particular, MCS' specialised analytical support and software development capabilities have proved an important contribution to the overall definition of the necessary advanced modelling techniques to be applied to the complex interaction of the SCR with the environment and boundaries.

This paper presents a typical SCR design procedure as part of an EPCI project, highlights the integrated approach to general riser technology, details the advanced methodologies for the nonlinear analysis of the SCR behaviour, and briefly presents the Saipem look forward for future riser technology.

KEY WORDS

Saipem, MCS, SCR; risers; riser systems; deep water; ultra-deep water; fully integrated approach; phased design procedure; advanced methodologies; FE analysis; flexible joint modeling; seabed modeling; probabilistic design; Saipem RCS Concept.

INTRODUCTION

For a large part of South Atlantic and GOM deepwater projects, the riser system is delivered as part of a large SURF EPCI contract; as such the design philosophy adopted must be compatible with important schedule constraints. This paper deals with three elements of the philosophy:

- Riser engineering and critical technology, within EPCI framework, requires an innovative 'phased design procedure' and 'fully integrated approach' in order to efficiently manage schedule constraint of the early procurement and critical interfaces.
- The capability to anticipate and efficiently implement 'advanced methodologies' for critical aspects plays a significant part of a successful project execution.
- Finally, effective feedback to riser technology innovation for future projects remains a key objective to ensure focused early phase engineering.

For SCRs connected to FPSOs (Floating Production Storage and Offloading) by means of flexible joints, the phased design procedure has been utilised by Saipem to cope with the specific challenges. For projects to date, the two critical design challenges are well known to be the characterisation of the behaviour at the vessel hang-off interface, typically by flexible joint articulation, and the modelling of the SCR interaction with the seabed. The response characteristics of the SCR at the vessel hang-off and at the seabed are complex nonlinear phenomena and it is often important not to restrict the modelling of such effects to linear approximations. For turret moored vessel applications, in particular, it is essential not to restrict the modelling of such effects to linear approximations. The integration of Saipem's EPCI fully integrated approach to critical technology and execution experience with MCS' advanced analysis/software capabilities, has been shown to deliver an optimum approach for SCR design.

The SCR phased design approach is split into three main phases:

- The *early phase* deals with identification of critical response for a given riser system, anticipation of advanced methodology requirements and any qualification planning. It is fully integrated with innovation in riser technology in areas such as riser novel concepts, metallic materials development (including CRA, welding & NDT) and strategy for non-metallic materials.
- The project specific *preliminary design phase* assesses in detail the riser response in parallel to the identification of the critical and non-linear responses at the vessel hang-off and at the touchdown in order to (i) fully confirm the feasibility of the proposed configuration, (ii) to deal with all project interfaces and (iii) to define the margins and uncertainties to be carried forward
- Following finalised project specific input data, such as pipe-soil interaction and including feedback from qualification activities