Characterisation of Al conductors for high depth subsea cable systems

Susanna **VENDITTI**, Enrico **CAZZULO**, Alessandro **TROLLI;** Francesco **CASLINI;** Federico **CORDÒ;** Prysmian Group, (Italy),
susanna.venditti@prysmiangroup.com, enrico.cazzulo@prysmiangroup.com, alessandro.trolli@prysmiangroup.com, francesco.caslini@prysmiangroup.com, federico.cordo@prysmiangroup.com

ABSTRACT

Welding is a process often used in the energy cable industry to join conductors, or metal sheaths, combining the parts together; when it comes to subsea cables, welding is used mainly on copper and aluminium. However, aluminium presents some challenges when it comes to welding. The aim of this paper is to describe the investigation carried out on a statistically significant population of aluminium welded joints, focusing on the metallurgical characterisation and on how the welding affects the mechanical performance. Typical welding features are going to be described along with the challenges that aluminium welding implies.

KEYWORDS

Aluminium conductors, welding, Flexible Factory Joints, Submarine Cables, High Depth

INTRODUCTION

Subsea cables play a crucial role in energy and communication across the globe. Nowadays, more than ever, the need for greener energy, less environmental impact, and more energy transmission, has highlighted the attention on the important role these cables play in our society. Currently there are cables installed everywhere all over the world. Depending on the type of connection, the amount of energy transmitted, and the morphology of the seabed, different designs are possible [1]. For example, the connection between wind turbines, or between wind turbines and the transforming station located at sea, is possible with inter-array cables. These cables usually op to 66 kV. Export cables are used for transportation of electricity form wind farms to land, and nowadays they operate up to 220 kV AC and up to 320 kV DC. Finally, interconnector sea cables are used for the transmission of large amount of energy usually over long distances.

As conductor, Copper (Cu) has been used since the first cable in 1850, but recently the high price of metal and deeper deployment on the sea bottom has pushed the scientific community to consider aluminium has a valid alternative. There is lot of engineering and research in subsea cable system and is important to underline that, while these cables represent a green way to transmit energy allowing the reduction of CO_2 emission, it is also crucial to keep the focus on improving the power and the design to ensure that the energy transition remain feasible, balancing the cost of the raw material and the manufacturing with the specific project requirements. The application of aluminium conductor for long submarine cable system implies the study and development also of conductor connection.

As reported in [2] the market demand includes also deeper interconnection, which submarine cable industry has experience from Italy-Greece Interconnector [3] in the '90s, and in the last decade SAPEI interconnector [4] and MONITA Interconnector [5]. Extensive activities in research and development have been carried out to move from existing technology to innovative ones to allow deeper installation thanks to lighter cable with fit-for-purpose mechanical performances: examples have been reported in [6] where light armours have been tested and the first project experience presented in [7]. Nowadays, with the award of the Tyrrhenian Link project, a new record in subsea cable water depth will be set. In this scenario, while many deep-water projects are arising, subsea cable design shall be lighter and aluminium conductor represents the one of the possible designs to reduce cable weight. Many research activities to improve mechanical performances of aluminium conductor (and welding of joints) shall be performed.

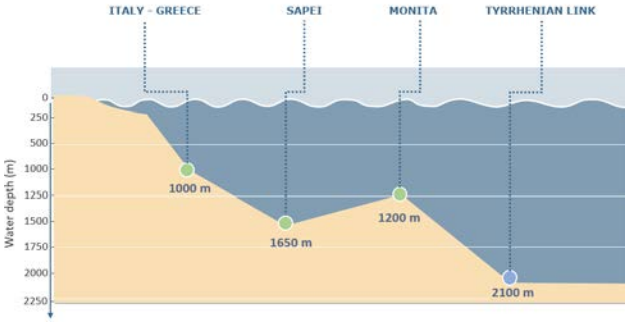

Figure 1 Project water depth installation trend.[2]

In this paper, a focus on aluminium conductor jointing within flexible factory joint will be discussed.

MATERIALS AND METHODS

As discussed previously, Cu has been the preferred element to be used as a conductor due to the high electrical conductivity and high mechanical performance. However, for high depth applications, where the cable weight plays a crucial role, Cu might not be so suitable anymore. In fact, during the cable laying operation, the entire cable system (cable with flexible factory joints and/or rigid joints) is submitted to an axial force that is the results of the depth of the seabed, sea waves shape and the weight of the cable itself. In this scenario a lighter cable will see much lower load and, consequently, stress. To this purpose, an