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Legal regime regulating the laying and protection of submarine cables in the Republic of Croatia

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ABSTRACT

One of the strategic development priorities of the Republic of Croatia is the development and construction of a modern telecommunications network and the availability of high-speed Internet throughout its territory, especially in rural areas and on islands. To enable this, it is important to build a reliable and resilient communication infrastructure. With the cooperation of all stakeholders in the construction, from telecom operators to local and state administrations responsible for the maritime demesne, and with efficient legislation, it is possible to achieve sustainable development of submarine cable infrastructure.

The paper provides an overview of the legal aspects of submarine optical cable infrastructure design and application at the national and international levels. Special attention is dedicated to the *analysis of a national legal regime regulating the protection and sustainable use of submarine cables. Thus,* the authors will provide critical analysis of a kind of dualism present in the application of the Ordinance on the Register of Concessions and the Ordinance on the Register of Concessions on the Maritime Demesne and offer suggestions for potential improvements of a national legal framework pertaining to the right of laying and legally protecting submarine cables.

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1 Introduction

Submarine cable infrastructure, i.e. energy and telecommunication cables are important submarine objects from both the economic and legal standpoint. Thus, their reliability, high-quality mechanical and transmission characteristics contribute to a better and more efficient connection and integration of coastal and island population within the global power supply and communication network. This paper will deal exclusively with submarine optical communication networks.

Submarine optical cables are one of the most important segments of national and international telecommunication networks. Nowadays, the demand for broadband services is constantly increasing. Transmissions of large amounts of data at high speed stimulate the continuous development and expansion of terrestrial and submarine telecommunication networks.

Special attention is dedicated to the role of international and national legislation in sustainable development, building and maintenance of the submarine cable infrastructure. The paper analyses the particularities of obtaining the submarine cable infrastructure installation permit and concession to lay submarine cables in the Republic of Croatia in accordance with the Maritime Demesne and Seaports Act, the Concessions Act and the Regulation on the Procedure for Granting Concession on the Maritime Demesne. Since transparency and availability of information on awarded concessions and concession holders are of paramount importance, it is compulsory to enter the relevant data in the Concessions register. In this context, the authors will provide a critical analysis on a kind of dualism present in the application of the Ordinance on the Register of Concessions and the Ordinance on the Register of Concessions on the Maritime Demesne and offer suggestions for potential improvements.

Submarine optical cable networks play an important role in the international telecommunication networks with 98% of all intercontinental communications being transmitted by submarine optical cables. Due to their small size, submarine optical cables generally have a negligible impact on the marine environment. However, activities associated with their design, installation, repairs and maintenance may cause damage and sometimes even long-term changes in ecologically and biologically highly sensitive marine environments. This paper analyses such activities and their impact on the marine environment and also deals with the potential damage of the submarine cables and threats they are exposed to due to human activities and natural factors. The paper also provides guidelines on how to improve their installation and protection in technical and legal terms.

2 Submarine optical networks

When stating the advantages of sending information via a fiber-optic network, special emphasis must be placed on the high speed of information transmission. To illustrate the importance of the information transmission rate, we will cite a few examples from history. In 1492, it took 6 months for Queen Isabella I of Castile to learn of Columbus' discovery of America. In 1865, it was not until 12 weeks later that the British learned of the assassination of US President Abraham Lincoln, and in 1969 the world learned of Neil Armstrong's landing on the moon after 1.3 seconds. Thus, it is no wonder that our time is called the information age.

The first submarine optical cable was installed in the Loch Fyne fjord in Scotland. Since then, several million kilometers of submarine cables have been laid in the oceans and seas around the world. Since the installation of the first transatlantic optical cable in 1988, optical cable systems have become increasingly important in information transmission. Reliable transmission of information, primarily generated by web applications, has become of vital importance for the global economy.

At present, there are over 400 optical cable systems that are either active or in the process of installation. Antarctica is the only continent on Earth that is currently not connected with the submarine optical cable network. One of the longest submarine optical cable systems in the world is the Southeast Asia-Middle East-Western Europe 3 system (SE-ME-WE-3), with a total installed length (including branches) of almost 40,000 km. [17]

Optical cable systems are used to transmit information at a speed that is equal to 99.7% of the speed of light, which is a significant advantage in comparison to satellite communication systems. Apart from that, other advantages of using optical cable systems as opposed to satellite systems are the higher level of safety and reliability and more efficient methods of installation and repairs. However, submarine cables are more susceptible to damage and failures caused by various human and natural factors. In order to improve methods of installation, maintenance and repair of submarine cables, first, it is necessary to analyse and understand the causes of failures and potential threats that can endanger the safety and reliability of the network operation. All the measures and procedures should be applied in accordance with the sustainable exploitation/use of submarine and coastal areas. [3], [13], [15], [26]

Submarine optical cables have been installed in the Croatian telecommunications network since the beginning of the 90s, almost simultaneously with the construction of the core terrestrial network. Since they are constituent parts of the core network, submarine optical cables are used to connect transmission devices, land and mobile telecommunication networks on islands with communication centre nodes situated on the land. Submarine optical cables laid to Italy and Greece additionally increase the capacity and quality of Croatia's international connections with the rest of the world. So far, in the part of the Adriatic belonging to Croatia's territorial waters, around 800 km of submarine optical fibre cables have been laid, connecting approximately 30 islands. The maximum depth at which the cables have been laid is 100 m. Since the distances between the island are relatively short, there was no need to install optical amplifiers on the seabed.

3 Legal aspects of submarine optical cable infrastructure design and application

Since the infrastructure of the submarine optical fibre network is quite sensitive by its nature, the need has arisen to legally regulate its use and thus improve its protection. There are laws dating back to the 1880s that refer to the laying of cables. The most important legal text referring to the high seas is the United Nations Convention on the Law of the Sea – UNCLOS. The Convention defines the rights and responsibilities of nations concerning their use of the world's oceans, establishing relevant guidelines concerning the business, environment and the management of marine natural resources. UNCLOS entered into force in 1994 and as of June 2016, 168 countries, including the European Union, ratified the Convention. UNCLOS affords the freedom to lay submarine cables and maintain and repair them outside territorial waters. [24]

The important regulatory instrument for the protection of the Mediterranean marine and coastal environment is the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution, which entered into force in 2004. Today, all 21 countries that have access to the Mediterranean Sea, including the EU countries, are included in the Barcelona Convention. Barcelona Convention primarily deals with the issues associated with the physical damage of the seabed that is the result of human influence (including construction at sea, dredging and fishing). However, the Convention does not offer special regulations that refer to the use of submarine cables. Adoption of

standards and regulations associated with the territorial waters is left at the discretion of each coastal state. [23]

3.1 International legal framework pertaining to the right of laying and legally protecting submarine cables

Legal regulations governing cable laying and cable maintenance and application of associated legal solutions depend on the marine and submarine areas in question. If the inland waterways and territorial waters are in question, they are integral parts of a coastal state's territory and as such, they are subject to its sovereignty and jurisdiction. Submarine cables and pipelines that are laid in inland waterways and territorial sea are subject to jurisdiction and sovereignty of the coastal state. The sovereignty of a coastal state is realized according to the Convention of the territorial sea and contiguous zone of 1958 and the UN Convention on the Law of the Sea of 1982 and other international regulations. In terms of legal protection, submarine cables laid in these sea areas are subject to coastal state's rules and regulations.

Another area in which submarine cables and pipelines can be laid is the continental shelf. Continental shelf is the area outside coastal state's jurisdiction, over which coastal state has no sovereignty apart from specific sovereign rights for the purpose of research and exploitation of natural resources and those rights are exclusive. The right to lay submarine cables is regulated by article 79, paragraph 1 of the UN Convention on the Law of the Sea of 1982 ("All States are entitled to lay submarine cables and pipelines on the continental shelf, in accordance with the provisions of this article"). In exercising this right, the states are required to adhere to the specific terms and conditions set forth by the Convention. Above all, when laying submarine cables or pipelines, States shall have due regard to cables or pipelines already in position. In particular, possibilities of repairing existing cables or pipelines shall not be prejudiced unless the coastal state is taking reasonable measures for the exploration of the continental shelf, the exploitation of its natural resources and the prevention, reduction and control of pollution from pipelines. [24]

In order to protect the interests of the coastal State to a certain extent, the Convention on the Law of the Sea grants the right to a coastal State to establish conditions which other states will have to adhere to while delineating the course for the laying of such cables and pipelines on its continental shelf. If submarine cables and pipelines laid on the continental shelf enter the territorial waters or territorial sea of the coastal State, then laying of such cables and pipelines will be subject to prior approval by the coastal State.

The right to lay submarine cables and pipelines on the bed of the high seas beyond the continental shelf is regulated by Article 112, paragraph 1 of the Convention on the Law of the Sea („All States are entitled to lay submarine cables and pipelines on the bed of the high seas beyond the continental shelf."). [24] As with the laying of cables and pipelines on the continental shelf, the coastal States shall have due regard to cables or pipelines already in position. In particular, possibilities of repairing existing cables or pipelines shall not be prejudiced.

If breaking or injury of a submarine cable or pipeline laid on the bed of the high seas occurs, according to the provisions of Article 113 of the Convention on the Law of the Sea, such occurrence shall be considered a punishable offence. In case of breaking or injury of submarine cables or pipelines, the jurisdiction for such offence will depend on whether the act was carried out by a ship or by a person. If breaking or injury was caused by a ship, it will be subject to the jurisdiction of the flag state. Likewise, if breaking or injury is caused by a person, it will be under the jurisdiction of the State that person is subject to. Legal protection of submarine cables and pipelines laid on the bed of the high seas is regulated entirely by article 113 of the Convention on the Law of the Sea. [24]

Article 114 of the Convention on the Law of the Sea stipulates the obligation of each State to adopt laws and regulations pertaining to making up the cost incurred as a result of breaking or injury of a submarine cable or pipeline of another owner caused by the owner of cable or pipeline subject to the State's jurisdiction.

Also, every State shall adopt the laws and regulations necessary to ensure that the owners of ships who can prove that they have sacrificed an anchor, a net, or any other fishing gear, in order to avoid injuring a submarine cable or pipeline, shall be indemnified by the owner of the cable or pipeline, provided that the owner of the ship has taken all reasonable precautionary measures beforehand (Article 115 of the Convention on the Law of the Sea).

3.2 Analysis of a national legal regime regulating the protection and sustainable use of submarine cables

3.2.1 Obtaining fibre optic submarine cable laying permit

According to the positive legal provisions of the Republic of Croatia, the physical laying of submarine cables across a suitable corridor is conditioned upon the prior procurement of appropriate permits and documents. Conditions for defining a submarine cable-laying corridor are regulated by a subordinate legal act, i.e. the Ordinance on conditions for the issuing of approval for laying and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia from 2007**.** [12], [14] The Croatian title of the Ordinance is somewhat misleading since it inadvertently suggests that the conditions for the authorization refer only to the laying of pipelines and not submarine cables. However, the first Article of the Ordinance on conditions for the issuing of approval for laying and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia states the following: "This Ordinance prescribes

all necessary conditions and standards for the approval of the activities such as laying of submarine cables and pipelines on the continental shelf of the Republic of Croatia and the conditions for the supervision of their installation and maintenance". Thus, it becomes apparent that the prescribed conditions for the authorization refer both to the laying of cables and pipelines on the continental shelf of the Republic of Croatia, with the only distinction being made in situations when the installed submarine cables and pipelines enter the territorial waters of the Republic of Croatia.

The Ordinance on conditions for the issuing of approval for laying and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia gives a definition of what constitutes a submarine cable. Thus, in accordance with the Article 2, paragraph 2, a submarine cable is a telecommunication or electrical cable laid on the sea bed or fed into a plough that lays it into a trench. [12]

Depending on where the submarine cable is laid, there are also bodies that are authorized to give consent for the cable laying corridor, which can either be the competent ministry or port authority. The Ministry issues the consent if a cable is laid on the continental shelf, while the competent Harbor Master's Office issues the consent if a cable that enters the territorial sea of the Republic of Croatia (Article 6 of the Ordinance on conditions for the issuing of approval for laying and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia). The question arises as to which Harbor Master's Office will be considered competent in the event that the submarine cable laying corridor extends to the area of competence of several Harbor Master's Offices. During future amendments to the Ordinance on the conditions for issuing permits for the laying of pipelines and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia, the authors propose to amend Art. 6. by adding a new provision that will prescribe the requirement to obtain consent from all competent port authorities.

The Maritime Code also contains provisions on the laying and maintenance of submarine cables and pipelines as well as the competent authorities granting consent for such activities. Thus, Art. 45 paragraph 3 of the Maritime Code stipulates that "the ministry approves and supervises the laying and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia that cross the territorial sea of the Republic of Croatia, and gives consent for submarine pipelines laid on the continental shelf of the Republic that do not cross into the area of the territorial sea of the Republic of Croatia." [18]

If this provision is compared with the provision from Article 6 of the Ordinance on conditions for the issuing of approval for laying and maintenance of submarine cables and pipelines on the continental shelf of the Republic of Croatia certain differences or inconsistencies are visible. According to Art. 45, paragraph 3 of the Maritime Code, the ministry is the only body that has defined authorities regarding the laying of submarine cables, while the Ordinance on the conditions for issuing permits for laying pipelines and maintaining submarine cables and pipelines on the continental shelf of the Republic of Croatia prescribes the competence of port authorities regarding specific activities. Given the inconsistent legal solutions, the authors suggest that the described provisions be harmonized in future amendments. The powers of the Ministry go in two directions, namely: a) approval of the laying of submarine cables, if they are laid on the continental shelf and cross into the territorial sea of the Republic of Croatia, and b) the right to supervise the laying and maintenance of such submarine cables. No appeal is allowed against the decision of the Ministry granting or denying the approval for the laying of submarine cables, but an administrative dispute may be initiated (Article 45, paragraph 4 of the Maritime Code). A legal entity that lays a submarine cable without the approval of the Ministry or its consent on the direction of laying the submarine cable commits a maritime offense as described in Art. 993, paragraph 1, item 9. of the Maritime Code.

3.2.2 Concession for special use of maritime demesne for laying fibre optic submarine cable

The investor's right to lay submarine cable across the approved corridor is based on the obtained concession. The procedure and conditions for obtaining this type of concession, which is a concession on a maritime demesne for special use, are regulated by the Maritime Demesne and Seaports Act, the Concessions Act and the Regulation on the Procedure for Granting Concession on the Maritime Demesne. Article 17, paragraph 2 of the Maritime Demesne and Seaports Act stipulates that a concession for the special use of maritime demesne is granted upon request, with special use being considered: "Construction on the maritime demesne of buildings and other infrastructure facilities (roads, railways, water supply systems, sewage systems, energy networks, telephone networks, etc.), buildings and other facilities for the purpose of defense, internal affairs, regulation of rivers and other similar infrastructure facilities"(Article 19, paragraph 1, item 2). [19] In the case of facilities of national importance, the decision on the concession is made by the Government of the Republic of Croatia, for facilities of county importance by the County Assembly, and for facilities of local importance by the city or municipal council (Article 19, paragraph 2 of the Maritime Demesne and Seaports Act). Which objects are to be considered objects of a certain category of significance is defined by a special legal act, namely the Ordinance on the designation of buildings, other interventions in space and areas of national and regional significance. Article 3 of this Ordinance stipulates that areas of national importance include "infrastructure corridors of submarine cables and pipelines in the territo-

rial sea of the Republic of Croatia that cross the borders of the continental shelf and cross the borders of two or more counties" while "infrastructure corridors of submarine cables and pipelines in the territorial sea of the Republic of Croatia which do not cross the borders of the county" shall be considered an area of county importance (Article 5 of the Ordinance on the designation of buildings, other interventions in space and areas of national and regional significance).

Based on the decision on the concession, the concession grantor and the authorized person enter into a concession agreement which regulates the specific purpose for which the concession is granted, the conditions that the concession holder must meet during the concession, the amount and manner of payment of the concession fee, guarantees and other rights and obligations of the grantor and the concession holder (Article 25 of the Maritime Demesne and Seaports Act). [19] The provision in Art. 54, paragraph 1 of the Concessions Act is especially important to note because it prescribes the so-called off period, i.e. the period of inactivity of 15 days between the delivery of the decision on granting a concession to each bidder and the conclusion of a concession contract. The 2003 Maritime Demesne and Seaports Act stipulated that the fee for concessions granted for the special use of maritime demesne is determined in a symbolic amount. However, the amendments to the Law in 2006 changed the above-mentioned provision in such a manner so as to exclude concessions for infrastructure construction (water supply, sewage systems, energy networks and telephone networks), in which case the fee is determined as per economic use of maritime demesne and based on economic justification, that is, the profitability of the economic use of maritime demesne, which is corroborated by a study on economic justification, the estimated degree of environmental impact on nature and human health and the protection of the interests and security of the Republic of Croatia.

The procedure for granting a concession on a maritime demesne for special use is prescribed by the Regulation on the procedure for granting a concession on a maritime demesne and as such it is also applied in the case of laying submarine cables. The provision in Art. 29 of the Regulation states that in the case of a concession for special use granted for the purpose of construction on a maritime demesne, the decision on the concession must contain the deadline within which the concession holder is obliged to obtain a building permit if required by special regulations. The laying of submarine cables is considered an act of construction on the maritime demesne, so the decision on the concession must certainly contain this information. If the concession holder does not obtain a construction permit within the given deadline, the decision on the concession ceases to be valid (Article 29, paragraph 2 of the Regulation on the procedure for granting a concession on a maritime demesne). [20]

As stated earlier, a concession on a maritime demesne for special use is given on request. In accordance with Article 26 of the Regulation, the application must contain: a) name, surname and place of residence of the applicant, b) conceptual design and/or statement on the intended use of the maritime demesne and c) statement of the competent spatial planning authority on the significance of the facility for which the permission for special use is required and a statement on the compliance of the conceptual design with the spatial planning documentation, and d) proof of registration if the applicant is not a natural person. When the competent body for conducting the concession procedure receives a written request, it is obliged to check within 30 days whether the area has been ascertained and registered as a maritime demesne. The competent authority shall make a decision on accepting the request. It should be noted that the Regulation on the procedure for granting a concession on a maritime demesne prescribes the content of the request for the award of a concession, but not the content of the decision on the concession. This legal gap should be filled by applying Article 24 of the Maritime Demesne and Seaports Act, which explicitly states what the concession decision should contain.

3.2.3 Concessions Register

Article 36, paragraph 1 of the Maritime Demesne and Seaports Act stipulates that concessions are entered in the Concessions Register, and paragraph 3 of the same article prescribes which body is in charge of keeping the register of concessions. In the case of concessions granted by the Government of the Republic of Croatia, the register is kept by the relevant ministry, and for concessions granted by the County Assembly, the competent administrative body in the county. The competent port authority grants a concession for the performance of certain port activities and keeps a register of concessions in writing, and may also keep it in electronic form (Article 72, paragraph 1 of the Maritime Demesne and Seaports Act). Furthermore, in Art. 36, paragraph 5 of the Maritime Demesne and Seaports Act, it is prescribed that the content of the register of concessions and the manner of keeping and accessing it shall be prescribed by the competent minister. Thus, in 2004 The Ordinance on the Register of concessions on maritime demesne was adopted, regulating the content and management of the Register of concessions on the maritime demesne. The Register is a public book consisting of the General Ledger (sheet A, sheet B and sheet C), the Collection of Documents and the Register Log and is modeled on land registers. Art. 2. of the Ordinance on the Register of Concessions on Maritime Demesne prescribes who keeps the register: the ministry in charge of maritime affairs for concessions granted by the Government of the Republic of Croatia, the administrative body for maritime affairs in the county for concessions granted by the county government and the Port Authority for concessions granted by the Port Authority. [22] The authors point out that this provision is not in line with the amendments to the Maritime Demesne and Seaports Act, which replaced the county government with the county assembly, and thus

the provision of the Ordinance on the Register of concessions on maritime demesne should have been amended accordingly. All concessions granted on maritime demesne for economic use and all concessions granted on maritime demesne for special use are entered in the Concessions Register (Article 4 of the Ordinance on the Register of concessions on maritime demesne). [22]

It should be noted that in 2018 the Ministry of Finance adopted the Ordinance on the Register of Concessions, which regulates the content and maintenance of the Register of Concessions, subjects of registration, verification of documentation and data entry, payment and recording of concession fees, review of data entered in the Register of Concessions and storage and protection data. [21] This is a unique Register of Concessions in which all concessions issued on the territory of the Republic of Croatia are entered, regardless of their type and activities for which they are granted, thus the concessions for laying submarine cables are also entered in the Register of Concessions. The Register of Concessions lists as a type of concession "a concession on a maritime demesne for special use for the purpose of building a cable connection". The Register of Concessions as a central electronic record of all concession agreements granted on the territory of the Republic of Croatia is kept by the Ministry of Finance, whereby it may entrust the keeping of the Register to another legal entity. The subjects of entry in the Register of Concessions are both parties to the concession agreement, and the person obliged to enter data in the Register of Concessions is the grantor of the concession. [21] The deadline for entering the data from the concession contract is relatively short and amounts to ten days from the day of concluding the concession contract. If this solution is compared with that of the Ordinance on the Register of concessions on the maritime demesne, then it can be observed that the deadline is much shorter given that the Ordinance on the Register of concessions on maritime demesne prescribes a period of thirty days from the conclusion of the concession agreement (Article 5). [22]

The Ordinance on the Register of Concessions does not prescribe the procedure in case the grantor does not enter data or does not enter it within the prescribed period, but prescribes the procedure of the competent ministry only in case of observed irregularities or when it is necessary to check the accuracy of entered data. In that case, the Ministry of Finance and /or the legal entity entrusted with keeping the Register of Concessions shall inform the grantor and, if necessary, request other documentation for inspection to verify the accuracy or to initiate the procedure of correction of data found to be incorrect (Article 7). [21]

Article 10, paragraphs 7 and 8 of the Ordinance on the Register of Concessions prescribes which data are considered public data and which as such are available to all natural and legal persons free of charge, namely: name of the concession grantor, OIB (personal identification number) of the concession grantor, name of the concessionaire, OIB of the concessionaire, date of signing or entry into force of the concession contract, the period for which the concession was granted, the expiration date of the concession, type of concession, name of the concession, area where the concession is granted and the cost and/or method of calculating the concession fee. [21] So, today we have in practice two ordinances that were adopted under the auspices of different ministries. The first is the Ordinance on the register of concessions on the maritime demesne, which as such is a special regulation and refers only to the records of concessions on the maritime demesne, and the second one is the Ordinance on the Register of Concessions, which is a general legal act and applies to all concession agreements and thus to those relating to the maritime demesne. Since the Ordinance on the Register of Concessions on Maritime Demesne has not been repealed, it still represents a part of the positive legal provisions of the Republic of Croatia, regardless of the fact that the issue of recording and keeping data on concessions on maritime demesne is regulated by a new by-law, so there exists a certain degree of the duality of legal regulation concerning the registration of concessions on the maritime demesne.

4 Impact of the submarine cable network installation on the marine environment

Submarine optical fibre cables are intended to be used in highly demanding marine environments. Optical fibres in the cable core are covered with additional claddings and strength elements that protect them from water, pressure, waves, currents and other natural forces acting at sea. Some of these factors vary with the depth of water. Thus, for instance, the effects of temperature and waves decrease with depth, while the pressure increases. On the other hand, sea currents can cause the shifting and damage of cables at any depth. Given that large cable lengths are laid in demanding environments, which requires large investments in both manpower and equipment, it is important to ensure reliable technical methods and measurement equipment.

Thus, for example, during the cable laying process, it is very important to monitor various cable properties, such as the minimum bending radius and the actual tension.

In recent years, a number of new measurement procedures have been researched and developed, which enable real-time system monitoring. Various sensor-based technologies are already available on the market that can be used for cable installation as well as for monitoring the marine environment. [2], [5], [6], [10], [11], [25]

The laying of cables is preceded by a number of activities of both technical and legal nature. Based on the telecommunications network operators' or owners' business decisions, landing points are determined, where the submarine cables are then connected to the terrestrial cable network. Also, as stated previously in the paper, various permits and approvals for the use of the seabed and the coastal area must be obtained.

At larger depths, the submarine cables are usually laid directly on the seabed without any protection. However, on shallow sandy bottoms, the submarine cables are buried in cable trenches.

Compared to submarine pipelines, submarine optical cables are very small. Their diameter varies from 17 mm to 50 mm and their impact on the seabed ecosystem is negligible. However, a number of activities associated with the laying of cables, their connection to terrestrial networks, maintenance and repair can cause permanent harmful damage to the seabed and have detrimental effects on the submarine living organisms.

Proper installation, maintenance and repair of submarine optical cables can guarantee their minimal impact on the marine environment. It has been noticed that the seabed cable has been laid on recovers after a certain amount of time. Naturally, the materials used for cable coating must be non-toxic and stable in saltwater. The emission of harmful substances from the cable is negligible because the potential pollution can only be caused by the conductors and cable's galvanized steel armour. These metal parts of the cable are made of copper, iron and zinc, out of which only zinc can enter seawater in negligible concentrations. The polyethylene coating of the cable is inert in seawater.

4.1 Cable route selection

Cable route selection is primarily determined by the telecommunication network operator's business plans as well as by the findings of submarine surveys and legal requirements for obtaining all the necessary cable-laying permits. Apart from that, it is also important to choose the suitable landing points, where the submarine cables are to be connected to terrestrial optical networks. Surveys of the seabed are usually carried out by survey vessels equipped with multi-beam sonar systems and satellite navigation systems. Surveys of the seabed help in identifying rocky bottoms, wrecks and other submarine installations that are to be avoided during cable-laying. During installation, repairs and maintenance of submarine cables, there are different elements affecting the marine environment that require the environmental impact assessment.

Environmental impact assessment report should determine the present condition of the submarine cable infrastructure; analyse failures, repair procedures, cable-laying and cable-protection methods; prescribe terms and conditions for the installation, repair and maintenance of submarine cables; define the types of cable-laying vessels and their equipment; determine the corridors in which fishing and anchoring are prohibited; establish protected marine areas; prescribe the requirements for cables entering the territorial waters; ensure maximum protection of both cable infrastructure and marine environment.

4.2 Cable installation

Regular transmission of information via submarine cable network depends on the quality of installed components and cables and the adequate cable-laying methods. The basic concepts of design crucial for the safe and economical cable installation are the following: suitable route selection, suitable knowledge of cable characteristics, experience in laying and protecting submarine cables in different environmental conditions.

Construction of landing points and laying and protection of cables must not damage the coastal and submarine environment in which these activities are taking place. Suitable and ecologically sustainable selection of landing points and construction of cable protection contributes to the preservation of the natural environment. Also, the cables themselves have to be protected in order to ensure reliable and high-quality transmission of information and eliminate failure and damage.

In areas where there is a possibility of damage to the cables due to human activity, the cables are usually buried in the seabed or protected by concrete moulds. It is customary to protect cables up to -10 meters of sea depth. At larger depths, the cables are laid on the seabed without additional protection. Damage to the seabed is caused by using a combination of ploughing and jetting for burial. Since the cable lifetime is approximately 20 to 25 years, the seabed recovers once the cable has been buried. The laying of cables affects the seabed in the width of approximately 5 to 8 meters. In comparison, trawling causes damage to the seabed in a width of more than 10 metres.

In order for the optical network to be resistant to failure and to provide continuous high-quality service, it is necessary to carry out regular maintenance and monitoring of the network. Once the cables' lifetime has expired or when it is necessary to replace them because they have become technically outdated, they must be removed from the seabed. Unfortunately, these cable removal operations also cause damage to the marine environment. [7-9]

5 Protection of submarine optical cable network

When it comes to the protection of submarine cables, conservation of the marine environment must be of paramount importance. Cable repairs are generally long-term activities that require the use of cable-laying vessels. Furthermore, when international cable systems are in question, it is necessary to obtain cable work permits from a number of states, which additionally extends the duration of repairs.

Although there does not exist a central database with all the information on cable failures, some estimates have shown that approximately 100 to 150 failures occur annually worldwide. Most of them occur in coastal waters at depths of up to 100 meters. [1], [16]

The most common threats to submarine cable networks are posed by human negligence and natural factors. The most frequent failures caused by human factors are fishing, anchoring and piracy. Natural disasters are rare, but when they do occur, they can cause extensive damage to submarine networks found in the affected area. Disruptions due to natural causes amount to less than 10% of the total number of failures.

5.1 Fishing

Trawling in coastal areas causes 44,4% of submarine cable disruptions. Annually, 50-100 cable failures caused by trawling result in communication network disruption and incur substantial repair costs. Furthermore, trawling on muddy seabed affects the seabed up to the depth of 5-20 cm. If the cable is buried at the depth of approximately 60 cm into the seabed, there is less likelihood of contact and damage. However, cable laid on the seabed can be damaged by fishing gear. If the cable is laid without suitable protection, fishing gear can sometimes cut through the optical cable cladding. [4]

One of the methods of protecting the cables from the fishing activity is surveying the seabed in order to determine the safest cable routes. In coordination with national bodies, it is necessary to establish safe zones for submarine cables, where anchoring and fishing would be prohibited. Such zones could also provide protected areas for endangered marine species. Naturally, if it is possible, the best protection of cables is achieved by burying them in the seabed. Fishermen could attend special educational programmes on the importance and methods of preventing cable damage. They could also be provided with all-day telephone support service in cases of cable damage and regularly updated sea charts showing new cable installations. In areas with intense fishing activity, cable routes should remain free in order to ensure safe manoeuvring of cable-laying vessels.

5.2 Anchoring

Anchoring is the second biggest cause of cable disruption and amounts to 14,6% of all cable failures. If several cables are installed close to one another at short distances, it is possible to damage all of them simultaneously. Even if such disruptions immediately raise the alarm on the transmission devices, showing the exact location of the failure, it is still difficult to locate the torn ends of the cable because they can fall on the sea bottom or be dragged away by the anchor hundreds of miles from their initial position. The search for the torn ends of the cable is performed by divers or remote-operated vehicles (ROV) at larger depths.

In order to protect the cables against ships' anchors, it is best to bury them into the seabed near ports, where port authorities should establish safe zones for submarine cables away from the anchoring areas and port approaches. The use of AIS (Automatic Identification System) could also contribute to the protection of submarine cables since it could provide timely information on the potential risks of damage to submarine cables due to vessels dragging.

5.3 Piracy

Any intentional disruption and damage to submarine cables are considered an act of piracy. Cases of cable wire theft have been recorded, especially during the cable installation process. Since the process of installation lasts for several days, reels of cables are left on the buoys or rafts during the night or during breaks. As a result, in certain cases, hundreds of meters of submarine cables have been stolen.

Protection from piracy and prevention of pirate attacks is the responsibility of governments and is considered a legislative issue. In cases of piracy, protocols between different state agencies should be clearly defined in order for the appropriate actions to be taken quickly. Such legislation should be applied both to national and international submarine cables, ensuring their protection from pirate and terrorist attacks. Protocols that should be followed in cases of piracy should include telephone contacts for emergency situations by which owners of cable infrastructure could be immediately notified for repairs. This requires accurate and updated information on the owners of cable infrastructure, as well as on the types and routes of submarine cables. Regular piracy attack drills should also be carried out in order to improve the response of all the participants in the protocol. Such drills could also help identify new ways to reduce the impact of this type of security threat.

6 Conclusion

It is in the opinion of the authors that adequate attention has been given to the legal regulation of laying and maintenance of the submarine cable infrastructure in the Republic of Croatia. However, an analysis of the relevant legal regulations has established that certain legal solutions require improvement.

There are currently two ordinances pertaining to the issue of keeping the records of issued concessions that were adopted under the auspices of different ministries. The first is the Ordinance on the Register of Concessions on Maritime Demesne, which as such constitutes a special regulation and applies only to the records of concessions on the maritime demesne, and the second one is the Ordinance on the Register of Concessions, which constitutes a general legal act and which as such applies to all concession contracts, including those related to the maritime demesne. Since the Ordinance on the Register of Concessions on the Maritime Demesne has not been repealed, it still represents a part of the positive Croatian legal system although the issue of recording and data-keeping on concessions on maritime demesne is regulated

by a new by-law, so there exists a certain degree of the duality of the legal regulation concerning the registration of concessions on the maritime demesne.

The authors also point to the fact that the Ordinance on the Procedure for Granting a Concession on a Maritime Demesne prescribes the content of the request for the award of a concession, but not the content of the concession decision. This legal gap should be filled by applying Article 24 of the Maritime Demesne and Seaports Act, which explicitly states what the concession decision should contain.

By improving the process of submarine cable laying, maintenance and repair and by establishing efficient methods of optical cable network protection, a great contribution could be made to the preservation of the marine environment. Reducing the risk of damage in selecting the suitable cable routes and landing points, establishing safe cable laying zones and enforcing the laws pertaining to the exploitation of the submarine environment would result in more resilient submarine cable networks both in national and international waters. Since the application of legislation is of great importance for the protection of submarine cable networks, national coastal law must be in conformity with the relevant international laws and conventions.

It is also necessary to define the rules and regulations referring to all the activities associated with laying, maintenance and repair of submarine optical cables and to the type of mandatory equipment to be used by specialized vessels for cable repair.

Using up-to-date vessel monitoring technology and providing timely feedback on cable installation work would significantly reduce the risk of failure caused by human activity. At the same time, faster transmission of information regarding cable failures would reduce the time necessary to locate them and thus reduce their repair time.

All of the above-mentioned activities require coordinated efforts by a number of participants. These participants are telecommunication operators, cable infrastructure owners, cable manufacturers, shipping companies, hydrographic institutes, port authorities and government agencies responsible for the management of marine and coastal areas. It is only the coordinated efforts of all of the abovementioned participants that can promote the awareness and knowledge of the ecologically sustainable laying of optical cables in the submarine environment and thus ensure they become global green communication networks.

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