Acoustic diagnostics of optical fibers strength in the cable

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At present one of the most actual problems for communication networks is the service life prediction for installed optical cables. This is explained by the fact that the operating time of the optical cables on the communication lines built in the 90s of the last century exceeded or close to the declared by cable manufacturers guarantee service life of 25-30 years. According to the generally accepted recommendations, the service life of the optical cable is estimated by the services life of the optical fibers [1]. This is justified since others structural elements in optical cable are used to protect optical fibers from external factors. To predict the service life of an optical fiber with a specified probability the well-known formulas are using, which define that target estimation determined by the relation of the applied to optical fiber load and its strength [1, 2]. Distribution of stresses in optical fibers of installed cable line can be measured by reflectometric methods. Optical fiber stresses due to tensile loads are determined from the results of measurements using BOTDR, and the bending stresses of optical fibers are estimated by the results of measurements of the distributions of optical fibers bends along cable line [3]. There are no recommendations for methods of non-destructive testing of the optical fibers strength in the cable.

For a long time, methods of non-destructive testing of products made from various materials based on acoustic emission were widely used [4]. Such methods based on measurement of acoustic emission signals of tested sample under the mechanical loading, and subsequent determination of the sample strength and/or localization of the defect according to the characteristics of the acoustic emission signal and applied mechanical load. To measure the acoustic signal emission and load control special sensors should be installed. Such solution was applied for evaluation of the strength of optical fiber bundles [5].

Over the past three decades distributed fiber-optic acoustic sensors (DAS – Distributed Fiber Sensor), which are characterized by resistance to electromagnetic interference, high sensitivity and large bandwidth, are widely used in various applications [6, 7]. In such systems the highly sensitive sensor is an optical fiber. Taking into account the characteristics of DAS, the possibilities of using these systems for measuring acoustic emission of an optical fiber itself were considered. A novel method for non-destructive testing of optical fiber strength in cable based on the acoustic emission method proposed in this paper. Distinctive features of this method: the mechanical load in the optical fiber is created due to the vibro-acoustic influence on the cable, and for measurement of the acoustic signal emission and control of the influencing vibro-acoustic signal the tested optical fiber is used. Conceptual scheme for one of the realization of the proposed method is shown on Fig. 1. Here 1 and 2 are the tested and reference optical fibers, respectively, 3 is a source of vibro-acoustic influence, 5 is the optical switch, 4 is a measuring system.

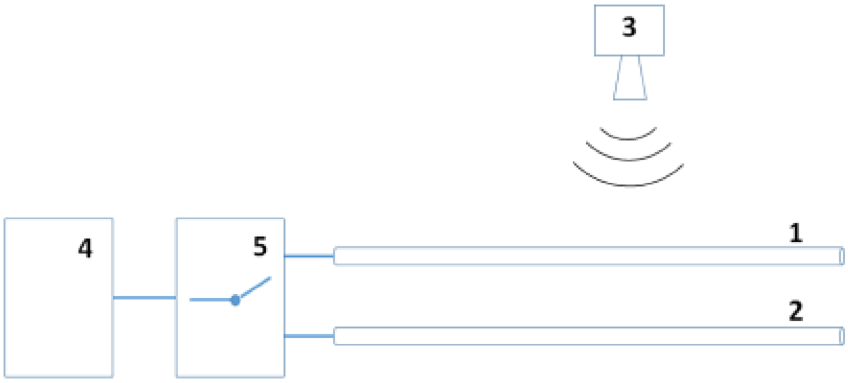

Fig.1. Conceptual scheme of the proposed method

In report the theoretical substantiation of the proposed method and the results of its experimental testing will be represented. The results of measurements of the influencing acoustic signal, acoustic emission signal and the results of optical fibers strength calculation for samples of optical cables which are in maintenance since 1996, 1998, 2011 and 2017 were represented. These estimates were compared with the estimates of the strength for same fibers obtained by the method of destructive control. The method of two-point bending was used [8]. Results of approbation demonstrate the possible application of the proposed method.

References

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