2018 Paris Session

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SC B2 JPS B2 & C3

Application of plastically pressed wires for high-voltage transmission lines

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The plastically pressed wires have high constructive density increased by the explosive and fatigue durability, high resistance to damage. They have found different application in the main sectors of Russian economics. The application of plastically pressed wires for high-voltage transmission lines is the perspective direction of promoting. It can increase reliability, and also decrease operational costs for the maintenance for new construction and reconstructed high-voltage transmission lines. Companies in Russia as Energoservice and Redayelli have accumulated considerable experience of design and production plastically pressed copper and steel-copper wires for overhead contact line system of railways transport. And also steel-aluminum wires various designs for high-voltage transmission lines for all kinds of voltage.

The characteristic example having a positive operating experience is the product – the overhead wire using in contact line systems of the railways. Using technology of plastically pressing at producing of copper or steel-copper overhead wires for contact line systems of railways has allowed to create new wire having high mechanical durability with a length which is slightly changing at fluctuations of temperature, resistance to corrosion, electric conductivity of copper, high aerodynamic characteristics. At the same time we combine overhead wire with standard fittings. Plastically deformed overhead wires of CC brand (copper compacted) are capable to perform functions not only as overhead wire, but also as more strengthening wires, electrical connectors of a contact suspension wire and wires of feeder lines. Essentially a new copper overhead wire has bigger durability without use of the alloys increasing electrical losses has a few advantages: low amplitude and intensity of aeolian vibration; low probability of a break wire after plotting of mechanical damages as a result of external influences; high level of fatigue resistance of metal of a wire; increase in life cycle due to self-quenching of oscillations; good aerodynamic characteristics; reduction of sticking of snow and formation of a sleet due to unique, more smooth construction; high mechanical strength; resistance to corrosion. By results of tests in Joint Stock Company Railway Research Institute for determination of relative speed of lengthening under identical conditions (working loading, the most admissible working temperature) the overhead wire of CC-120 which is plastically deformed copper is comparable only to the overhead wire of a standard design from bronze alloy of the increased durability (Br2). Comparison of CC-120 with standard copper and bronze (Br1) the overhead wires was shown considerably by the worst indicators of the last. Mathematical modeling of stretching of plastically deformed steel-copper wire for contact line system of railways has allowed optimize its design more than for 30% has led to increase in explosive effort.

Special type of wires with increased by durability and capacity are plastically pressed out bare high-strength (ASHS) and high-temperature (ASHT) steel-aluminum wires with a linear

contact of wires. Plastically pressed steel-aluminum wires differ from standard wires of a classical design in the fact that to a twist the core is plastically pressed, subject to similar operation to twist current wires. In comparison with classical the new plastically pressed wires have the big durability and current capacity that is confirmed with results of laboratory researches. Unlike the wires which have already become the standard decision with high (to 90%) density of filling of section due to use of the profiled wire in plastically pressed out ASHS wires initially round pro-wolves from aluminum and high-strength steel are used. At plastically pressing sinking density of filling of section not is reached below, than at assembly of wires from profiled wires, and costs of an initial wire are much lower. Use of methods of mathematical modeling has allowed to optimize the geometrical sizes of the ASHS elements and parameters of plastic deformation providing necessary extent of filling of section. Plastically deformation with the extent of sinking of cross section calculated for each of materials prevents untwisting of a wire and mutual movement of his elements under the influence of forces on stretching, and because of mechanical hardening durability aluminum the wires increases by 1,5 times. In a design of wires of ASHT instead of a wire from pure aluminum are used domestic wire from system alloys aluminum-zirconium of various chemical composition.

Comparative assessment of parameters of standard wires aluminum-steel of various types and calculations on mechanical durability at various modes of climatic conditions have shown that wires of ASHS, ASVT allow to solve flexibly problems of design and construction of high-voltage transmission lines. The cost of wires of ASHS, ASHT slightly exceeds the cost of classical wires, and higher durability allows to receive economy of capital expenditure due to decrease in quantity of support. Capacity due to application of wires of ASHS, ASHT can be increased at a size up to 1,7 times in relation to wires AS of the same diameter. In comparison with wires AS of the same capacity and a smooth external contour loads of support allow to reduce the smaller diameter of wires of ASHS, ASHT and to reduce pro-weight arrows due to decrease in wind load of wires and reduction of thickness of walls of ice in the same climatic zones. For an assessment of influence of wind on wires with various form of cross sections the two-dimensional model of the mathematical modeling which has shown that average decrease in wind load of a wire of ASHS (ASHT) rather standard AS of close permissible current load makes 25-40% was used. The results of comparative experimental modeling of the mechanism of emergence and a gain of the glazed frost deposits on samples of wires in climatic installation in laboratory of the national academy of construction and architecture have shown that for the modeled experimental conditions corresponding to the 2nd area on an glazed frost wall, with other things being equal intensity of formation of glazed frost deposits on the compact or plastically pressed wires (ASHS, ASHT) 12% lower.

By results of the high-voltage electric networks which are carried out in testing laboratory of electric equipment according to requirements of electromagnetic compatibility of scientific and technical center of Federal grid company of unified energy system of comparative tests it is established that for wires of identical diameter tension of emergence of the crown category on a wire of ASHS 197/55 of production of Energoservice company (142,2 kV) due to smoothing of a profile at plastically pressed is 5,7% higher than tension of emergence of the crown category on a wire of the AS brand 185/29 (134,5 kV). Increase in tension of emergence of the crown category allows to reduce lose of energy by acoustic noise and a luminescence, to lower a radio noise, vibration of a wire, and also release of ozone and other substances.

The simulation of passing of an alternating current which is carried out by the finite-element method on steel-reinforced aluminum wires of different construction showed that contrary to the set opinions which found reflection in Russian rules for electrical, the direction of lays of aluminum wires in case of even quantity of lays practically doesn't influence separation of warmth in the steel core. Between wires as a result of plastic pressing of the steel-aluminum wires like ASHS allows to reduce formation of electrical contacts of high conductivity by 10% of heat release in the steel core. Plastically pressed bare ASHS and ASHT steel-aluminum wires allow to increase distance between the line support by length up to 40% from standard flight that

is the urgent task in case of construction of new line. For electricity lines of 110 kV calculation of dimensional flight of a wire of ASHS 128/37 in comparison with wires of approximately identical sections and diameters (AS 120/27; AS120/19) showed that application of a wire of ASHS 128/37 allows to increase dimensional span in comparison with a wire AS 120/27 from 212 to 294 m. In case of the bigger content of steel (the ratio of the areas aluminum/steel at ASHS 128/37 is equal 3,45 in comparison with 4,3 at AS 120/27) the wire has equal diameter of 15,2 mm, and its conductivity is 8% higher.

In this report, the experience of creating a new wires with Innovative design for a Compact lines is presented. The created decisions in design and ways of receiving plastically pressed wires are protected by patent documents: patents for a lightning-protective wire – No. 2361304, No. 2490742; steel-aluminum wires of ASHS and ASHT – No. 132241, No. 2447525. Complex competent using of the developed plastically pressed wires at new construction and reconstruction of high-voltage transmission lines of 35-750 kV can significantly increase their reliability at influence of all range of climatic loadings, increase capacity, lower capital and operational expenditure. The report presents the results of theoretical and experimental studies carried out on mathematical and physical wires models and aimed at developing Innovative design wires with best operating characteristics.