ABSTRACT AND REFERENCES

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IMPROVING THE ABRASIVE RESISTANCE OF A SLIDE FRAME IN A MORTAR MIXER (p. 6–14)

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A method has been proposed for machining the outer and inner conical surfaces of the wrist pin and insert, which represent a sliding friction pair on the mortar mixer frame. The machining implies the application on the conical surface of parts, preliminary prepared through turning, of a wear-resistant material in the form of a hard alloyed nickel-based powder. It is applied with a special burner with a hopper-dispenser filled with powder. The result of mixing a combustible gas (acetylene and oxygen) in the burner with the powder from the hopper is melting.

In the course of implementing a given technological process, by using mathematical modeling methods, we have determined the optimal mode parameters (PG10N-01 powder consumption is 33.5 g/min.; oxygen flow rate is 7.0 l/min; acetylene pressure is 0.043 MPa) for the gas-flame surfacing, which ensured maximum effect, that is, the greatest strength of adhesion (45 MPa) for the surfaced coating. The surfaced coating quality was checked by using a pin method for determining the adhesion strength between the new coating and the base on a tensile testing machine.

A series of experimental studies into the enhancement of abrasive resistance of a sliding frame, namely a comparison of the surfaced coating with other well-known wear-resistant materials such as steel ShKh15, KhVG, were carried out at a specially designed experimental bench. Its structure is based on a vertically drilling desktop machine adjusted to the conditions of a working process that occurs inside the body of a mortar mixer. These include an abrasive medium, and the radial and axial efforts. To determine the axial load on a frame, we have proposed a structure of the hydraulic device, which includes a pressure gauge, a piston, a sleeve, and a ball. The axial load has been found for the most unfavorable conditions of mixer operation. Its value was implemented at an experimental wear bench. In addition, we have performed a series of experimental studies to determine an optimum angle of the cone at the apex of the wrist pin and insert in a conical slide frame for the minimal wear.

Using the proposed technique of a gas-flame surfacing could significantly improve the abrasive and corrosion resistance of a slide frame, thereby prolonging the lifespan of a mortar mixer in general, as well as the overhaul cycle for equipment designed to prepare soluble mixtures used for construction.

Keywords: gas-flame surfacing, abrasive wear, slide frame, hard alloyed powder, technological process.

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DETERMINING THE INFLUENCE OF THE CONDITION OF ROCK-DESTROYING TOOLS ON THE ROCK CUTTING FORCE (p. 15–20)

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At present, the most common tools for drilling operations are those rock-destroying ones that are equipped with cutting elements made from polycrystalline diamonds (PDC) and diamond carbide inserts (DCI). Given this, it is a relevant task to study the influence of the degree of wear of cutting elements on the strength and energy parameters of the process of rock destruction. In order to determine this influence, we have experimentally investigated the cutting process involving a single cutter under laboratory conditions. The mean values of the cutting force components (circular ((P_z) and normal (P_y)) have been established at the cutting depth 0.5; 1.0; 1.5; and 2.0 mm, at a varying degree of the cutting element wear (a flat of 0; 5.0; and 8.0 mm). We have determined the magnitude of cutting work and the specific energy of rock destruction. At a cutting depth of 0.5 mm, with an increase in the cutting element wear rate from 0 to 8 mm, the magnitude of work grows from 0.06376 to 0.121 N·m. At a cutting depth of 2.0 mm, the magnitude of work increases from 0.624 to 3.603 N·m. The energy intensity of the rock destruction process increases, with an increase in the cutting depth from 0.5 to 2.0 mm, from 3.88 kJ/m^2 to 11.66 kJ/m^2 for a sharp cutter. Based on the study results, we have built dependence charts of the average values of the cutting force components and its normal component (P_y) on cutting depth and the cutting element wear degree. The results obtained have shown a significant influence of the size of the wear flat on the increase in the process strength parameters, which is the basis for regulating a wear degree of cutting elements during drilling. We have established the tendency towards a growth in the resultant force and specific work of rock cutting by a cutting element with an increase in wear degree. This makes it possible to determine, based on the indicators of fluctuations in the instantaneous strength values during drilling of wells, or based on a change in power, the wear degree of the cutting elements, and to predict the probability of their destruction.

Keywords: destruction of rock when drilling, well drilling, PDC bits, cutting force.

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MODELING THE TRAJECTORY OF MOTION OF METALLIC AND ABRASIVE PARTICLES IN A WASHING GUTTER (p. 21–31)

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Thousands of tons of metal-containing sludge are produced every month at machine-building, especially bearing producing and metallurgy enterprises where is processed. In the production of bearings, up to 10.0 thousand tons of sludge containing up to 90 % of the metal fraction is produced annually. At present, the sludge is practically nonrecyclable and brought to landfills degrading the environment.

To increase the uniformity of metal powder at the stage of sludge washing, it is necessary to separate the solid articles by their density.

To solve this issue, a comprehensive system of environmentally friendly technology is used for reclaiming the grinding sludge where in the process of movement of the sludge particles in a flow of detergent solution, their washing and separation by density take place. The study of the trajectory of motion of solid sludge particles makes it possible to set the mode parameters of the gutter which provide effective separation of particles by density. This enables determining the height of separator installation in the solution flow and obtaining a larger percentage of homogeneous metal particles.

The main parameters of the washing gutter which can ensure effective separation of metal and abrasive particles include length and width of the gutter, level of the solution flow, flow rate of the solution, flow rate of fluid through the sidewall of the gutter, flow rate of solution through nozzles, number of nozzles and distance between them.

Based on theoretical studies and a mathematical model describing the motion of metallic and abrasive particles in a detergent solution, a program in the C++ language and in the C++ Builder 6 programming environment was developed.

The developed program makes it possible to simulate trajectories of motion of metal and abrasive particles in the detergent solution flow in the gutter. In the mode of random particle parameters, diameter in a range of 18–500 μm for metal particles and in a range of 31–200 μm for abrasive particles is selected.

Keywords: grinding sludge, metal and abrasive particles, trajectory of motion, washing gutter.

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REVEALING PATTERNS OF THE EFFECTIVE MECHANICAL CHARACTERISTICS OF CELLULAR SHEET POLYCARBONATE FOR EXPLOSION VENTING PANELS (p. 32–39)

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Explosive concentrations of various substances can accumulate inside industrial premises. In the presence of a sufficient amount of oxygen and an ignition source, such a situation could lead to explosion that may result in the destruction of building structures and the building in general. Strengthening the stability of supporting structures is aimed at protecting industrial premises against possible destruction by explosion indoors.

One of the effective ways to protect construction structures against the excessive pressure of explosion is to use explosion venting panels. In order to solve practical tasks on protecting industrial premises and structures against explosion, one must be able to choose both the area and parameters for explosion venting panels. In addition, in order to reduce the related loads to safe quantities, it is necessary to properly calculate the bearing structures in terms of dynamic stability while maintaining their carrying capacity. The set task to ensure protection against explosion by applying explosion venting panels with flexible elements can be solved through integrated accounting for mechanical properties of cellular polycarbonate sheets.

We have performed experimental research into performance of the inertia-free explosion venting panels with flexible enclosing elements exposed to dynamic loads under conditions of explosion. Based on the obtained results, the effective rigidity and critical displacement of cellular polycarbonate sheets of flexible elements have been determined. It has been established that for cellular polycarbonate sheets with a thickness of 4–8 mm effective rigidity ranges within 301–215 N·m; the critical displacement of edges in this case is 2.9–9.8 mm.

A mathematical model has been proposed that takes into consideration the influence of geometric dimensions and the critical value of deflection in a polycarbonate sheet as the flexible element of fencing on the operational conditions for explosion venting panels.

Keywords: explosion venting panels, polycarbonate cellular sheet, effective mechanical characteristics, experimental-estimation method.

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DOI: 10.15587/1729-4061.2020.194584 PREDICTION OF THE SERVICE LIFE OF DEEP-SEA CONICAL ACRYLIC PORTHOLES AT DESIGNING (p. 40–46)

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Conical deep-sea portholes (CDSP) from acrylic are widely used in underwater equipment. Due to the specific properties of acrylic, operating conditions and the stress-strain state of CDSP, it is difficult to evaluate service life and choose optimal geometric characteristics. The experimental studies and numerical calculations of the stress-strain state of CDSP from acrylic under various levels of hydrostatic pressure were made to develop an optimal design method of CDSP considering operating conditions. CDSP from acrylic were exposed to long-term (up to 7 days) and cyclic (up to 2000 cycles) hydrostatic pressure of 40, 60, 70 and 80 MPa.

The deformation of the CDSP was periodically determined at no less than 20 experimental points with the help of displacement sensors. Experimental dependences of the CDSP displacements were obtained under long-term and cyclic exposure to hydrostatic pressure. According to the method of stress-time analogy, a forecast of the CDSP deformability for 10 years is made.

The series of CDSP calculations with cone angles of 60–150° and relative thicknesses of 0.35–0.60 using the finite-element method was made. The calculations obtained by the finite-element method coincide with the experimental results, which demonstrated the adequacy of the adopted CDSP design scheme – continuous sliding of the translucent element with friction along the supporting surface of the porthole body. It is shown that an increase in the cone angle reduces the deflection of the CDSP, and equivalent stresses are minimal at cone angles of 75–105°. The synthesis of stress-strain state calculations by the finite-element method in aggregate with the prediction based on short-term tests allows selecting the optimal geometric characteristics of CDSP, depending on the operating conditions.

Keywords: deep-sea portholes, heat aging, acrylic, hydrostatic pressure, prediction of properties, service life.

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DOI: 10.15587/1729-4061.2020.195193 IMPROVING THE RETENTION CAPACITY OF CLAMPING ELEMENTS (p. 47–51)

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An analysis of the discarded drill pipes that had been used in wedge grips has revealed that the main reason for pipe rejection is the reduction of a pipe wall as a result of plastic deformations, due to damaging the pipe surface by the die teeth. The long-term exposure to loads results in the plastic deformations of cylindrical parts, which could lead to unacceptable damage and distortion of the shape. In the oil industry, when drilling and casing pipes are clamped, stresses over some areas in the capture zone exceed the fluidity limit. Multiple clamps of the pipe could reduce the wall of the pipe in the capture

area, which leads to premature failure of the pipe. Pipe crumpling occurs not immediately when the load is applied but gradually, by local plastic deformity of the pipe at various points in length and circumference, where the stresses exceed the limit of the fluidity of the pipe material. In order to prevent unacceptable deformations of pipes during hoisting operations, we have considered the possibilities to reduce loads.

In this regard, special attention has been paid to the design of clamping jaws that provide the increased retention capacity and the technology of their manufacture. The greatest retention capacity is ensured by jaws with an oblique intersecting notch. In such jaws, the teeth of the notch are arranged chequerwise. This makes it possible to exclude the formation of vertical grooves on the body of the pipe due to slippage induced by the axial load. However, the manufacture of such notches at the inner cylindrical surface of clamping jaws is associated with some difficulties. This relates to that there are no standard tools for making such notched surfaces of complex configuration. The result of our research is the designed and manufactured special tool, as well as the technology for its fabrication. That has made it easier to cut the notches on clamping jaws that ensure the reliable capture of drill pipes.

Keywords: wedge grip, drill pipes, clamp force, jaw notch, retention capacity.

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SIMULATION MODEL OF THE MORPHOLOGICAL FIELD OF DATA FOR CONSTRUCTING A UNIVERSAL DESIGN OF TROUSERS (p. 52–61)

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The reported research into the influence of a database on the processes of universal design formation has established a mechanism for the interactive application of clusters of size-based attributes. It has been proven that the typological series of a structural size characterizes a conditional standard body figure of the youth type. This has made it possible to determine the mobility of structural zones in accordance with the morphological features of a body structure at the stages of forming the base for a design. Our experimental study has confirmed that the boundaries of functional sections in the grouping of structural zones are governed by the variability of gains by the basic structural points. That leads to the poly-variance of the pelvic section when forming properties for the proportionality of trousers. Specifically, it has been established that due to identifying the similarity of structures based on a scaling ratio, the adequacy of a database is improved by coordinating the information base for constructing structural zones. This allows us to assert the reliability of the mechanism that forms clusters within an anthropometric database, as well as practical attractiveness of the proposed interactive design technology. It has been shown that the variance in gains ensures decomposition of the closed contour of a part at the points of change in functional sections, which is the advantage of the current research. We have shown the prospects for extending the range of morphological types based on the age-trait biodynamics of functional movements.

Thus, there are grounds to assert the possibility of targeted control over the processes that form a universal design by employing an integrated database that combines the clusters of size-based attributes, gains, as well as a structural zones nomenclature.

Keywords: cluster, size-based attributes, universal design, structural zones, gains, morphologic field.

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