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RESEARCH OF THE INFLUENCE OF DEFORMATION SPEED ON ENERGY AND POWER ADJECTIVES OF THE PROCESS OF THREE-POINT COLD BEND BREAKING

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One of promising techniques of reduction of the level of plastic strain is the use of high-speed loading. Of great importance is the study of the issues of deformation speed influence on strength properties of metals by the following scientists: Ioffe A.F., Davidenkov N.N., Shevandin E.M., Hopkinson D., Erdogan E., Ekobori T., Pearson D., Sokolov L.D., Polukhin P.I., Goon G.Ya., Galkin A.M., Parton V.Z. and others [1]. Development of new high-speed processes of partition of high quality rolled metal into cut-to-length sections must be based on the up-to-date methods of experimental analysis. Knowledge of material behavior during an impact is one of the necessary requirements of correct choice of processing methods of partition.

However determination of the blow effort amount because of very short duration of impact represents a definite problem. Short-time loading action and arrival of wave effect with the increase of deformation speed considerably complicates the analysis of materials behavior and the influence of loading speed on its mechanical properties.

Numerous experimental data prove the loading speed susceptibility of materials, i.e. the loading speed can both increase and diminish the strength properties depending on the structure, composition and technology of their obtaining. However announced experimental data is contradictory in itself and its volume is insufficient, especially as it applies to the processes of partition of high quality rolled metal into cut-to-length sections.

With the purpose of obtaining such information experimental researches have been conducted on the three-point cold bend breaking of samples of different grades of steel under static and shock loadings.

The experiment employed cylindrical samples of rolled metal of different steel grades of 16mm in diameter and 150mm long, being in plastic (Ст.3), elastoplastic (Сталь 20, 45, 40Х) and fragile states (Сталь 60С2, ШХ15). Stress raisers in the form of annular grooves of triangular profile with the following parameters were preliminarily applied onto the samples with the use of a lathe tool: depth – 1 and 3 mm, radius at the top – 0,15 mm. The load application lever – 50 mm [2].

The dimensions of deformation areas and samples' destruction were determined by the analysis of surface fracture with the use of microscope.

Determination of geometrics characterizing geometrical accuracy of the samples was conducted using the method of macrostructure analysis measuring absolute and relative values of geometric distortions with the use of universal testing tool.

Fig. 1 shows the registration pattern of the experimental data (Fig. 1a), structural chart (Fig. 1c), photograph of the experimental equipment (Fig. 1b) and the rigging (Fig. 1d) [2].

Model charts of time dependent energy and power parameters of the three-point cold bend breaking process of the partition of samples of different grades of steel with the concentrator of tensions Δh=3mm at static and shock loadings are presented in Fig. 2 [2].

The variation $F(t)$ at the three-point cold bend breaking of samples with the concentrator of tensions Δh=1mm at static and shock loading is presented in Fig. 3 [2].

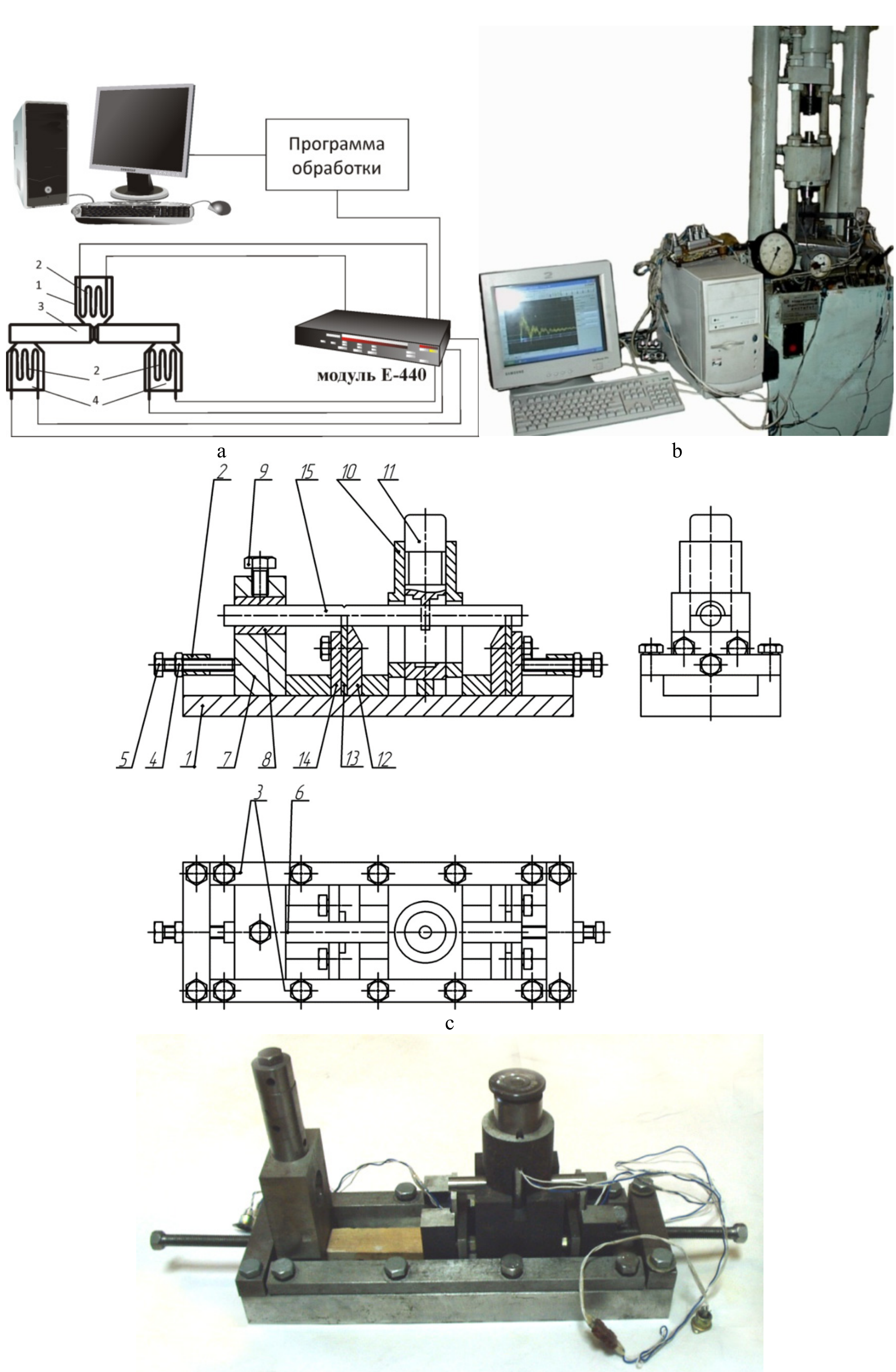
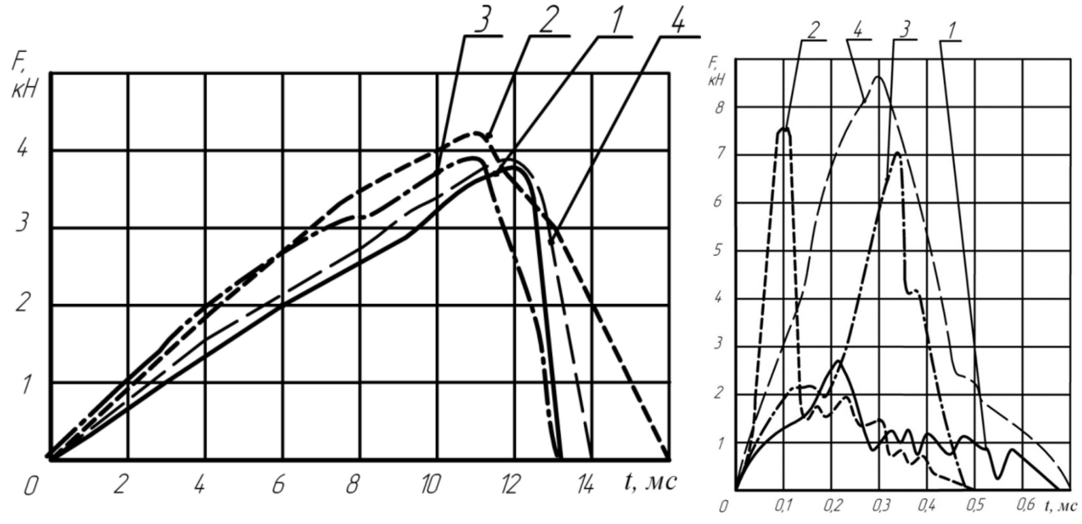


Fig. 1. Pattern of experimental data collection (a), structural chart (c), photographs of the experimental equipment (b) and rigging (d): 1 – breaking mechanism; 2 – strain sensors; 3 – sample ; 4 – supports [2]



a b

Fig. 2. Dependence of breaking mechanism force on the time for the samples of different steel grades at ∆h=3mm: 1 – Сталь ШХ15; 2 – Сталь 20; 3 – Сталь 40Х; 4 – Сталь 45, a – static loading; b – shock loading [2]

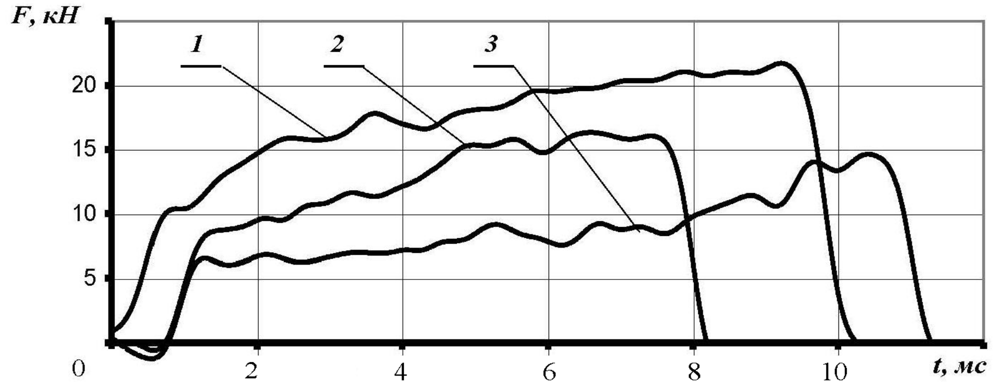


Fig. 3. Dependence of breaking mechanism static force on the time for different steel grades at ∆h=1 mm: 1 – Сталь 60С2; 2 – Сталь 45; 3 – Ст.3 [2]

Discussion of obtained rezults. Comparison of top breaking force at static and shock loadings was estimated by the dynamic magnification factor $k_d = F_{bd}/F_{bs}$, which for different grades of steel made up accordingly: ШХ15 – 0.7; 60С2 – 1.6; 45 – 2.0...2.2; 40Х – 1.8...2.1; 20 – 1.6...1.8. These results conform with data cited in [5], where k_d with the increase of deformation velocity up to 100mps for Armco iron is increased in 3.4 times; for steel 45 – in 2.8 times; for steel 3 – in 2.9 times; for high-strength steels, e.g. ШХ15 – $k_d < 1$, what is explained by the initial processes of destruction in metal and allows to consider structural factor to be a determining one at the initial range of high-speed tests of materials.

References

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2. Karnaukh S.G., Karnaukh D.S. Research of the influence of deformation speed on energy and power adjectives of the process of three-point cold bend breaking and on alignment integrity of raw parts. *Metallurgical and Mining Industry*. 2011. №3. Vol.3. P. 107-114.