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©Kravtsov M.K., Obolenskaya T.A., Beletskaya I.V.

WAYS TO INCREASE THE DURABILITY OF MATERIALS IN MODERN MECHANICAL ENGINEERING

1. Statement of the problem

The modern structural materials must have high specific strength as for density, low and high temperatures, high dynamic strength, steadiness, action of aggressive medium and irradiation.

In the past 25 years, the strength of basic structural alloys (on the base of aluminum, titan, iron, molybdenum, magnum and etc.) has increased only about 12-15Mpa. In the same time, specific elasticity module of these materials have remained the same. Besides, scientific investigations and experimental tests of pitch (tar) and plastics showed that further essential increasing of its strength and module is impossible. Physicists noted that the theoretical strength of crystal bodies can approach 1000kp/mm^2, but practically, in spite of efforts of the scientists, the steel strength has approached only 1/4 of it and there is unlikely further increasing.

2. Research analysis

The matter is that in crystal bodies, a great quantity of the smallest defects, called dislocations take place. The number of dislocations approaches many billions even in very small volume of metal or alloys.

The investigations showed, that crystals without dislocations is possible to get only in kind of fibers, pellicle, needles with very thin cross-sections.

The maximum specific strength, as turned out, is inherent not to the thinnest steel wires but carbon fibers.

Yet now there are carbon fibers whose weight is 5 times less than steel and whose strength is 3 times more than the best steel alloys and the elastic module is much more that for steel.

To obtain such composite it is necessary to connect with special matrix. The fibers plus matrix make various compositions, that is why its name is composite.

The fibers are made from carbon, silicate glass, bor, and many others, and also from organic substances.

The temperature of exploitation condition is connected with composition of the matrix.

Polymer composites can work in temperature up to 200°C with steel frame from 20°C to 500°C, and ceramics more than 1000°C. And the carbon fibers in carbon matrix can work in temperature of more than 2000°C.

It is difficult to imagine modern aircraft and rocket technics without composites. Body of airplanes, cabins of helicopters, brads of airplanes and helicopters, protecting fairing, body of rocket engine and many other structural elements, which demands increasing technical requirements and can be practically produced only by due composites.

Transparent and nontransparent panels, roofs windows frames, bath-shower basins, air tubes, reactional apparatus and various cubic contents, chemical equipment, radio-transparent and **crio** steadiness tubes, compressor bodies, this is a list of parts from composite used in building, chemical industry, space, radio and **crio**-technics. In this way, the materials, armed by fibers, consist of reliable class of new structural substances.

It is very important for structural materials, besides limit of strength and elastic properties to have limit of fatigue, cycle strength and enough tough of distraction, which are very necessary for increasing exploitation safety of material.

Usual high strengthened steels have low ductility, high sensitivity for stress concentrations and comparatively low fatigue limit.

Composite fibril materials, having high limit of strength and still less ductility than high strengthened steels, but they have less sensitivity to stress and high fatigue limit.

It is explained that the materials have different mechanism in developing of cracks. In traditional homogeneous steels and alloys the development of crack goes progressively. The velocity of crack creation increases, going further and further between structure coins. But it is different in the crack development of armored plates. The crack usually creates in matrix and its development meets obstacle. The fibers brake of crack development and the period of relatively stability comes.

Analyzing character of composite distribution, it is necessary to mark that it consists of row of successive stages, each different from the other by redistribution of stress between armored fibers.

By such manner, in composites two contrary properties, inherent in structural materials – high strength limit and sufficient ductility of distribution are combined. The high strength is being approached by use of brittle high strengthened fibers, and sufficient ductility of distribution is caused by ductile matrix and specific mechanism of distribution, energy diffusion of composition.

Classification of composites.

Composites may be classified for next indications: 1) by method of armour, 2) material of matrix, 3)method of forming, 4)geometry of matrix, 5)purpose of element.

According of method of armour the materials are with oriented armour, when armour is arranged to strictly definite order, and irregular distributions of armoured elements. In the first case the composites have clearly expressed anisotropic properties, the highest meaning of which is reached along the direction of situation of armoured elements, in the second case – these composites are isotropic. The armoured material may be: glass, carbon, organic, for fibres, may be also using of paper, pasteboard and others. For using of dispersion armoured composites may be used the smallest crystals – oxides of aluminum, zirconium, titanium, beryllium, carbide of boron, silicon and others.

According of matrix materials the composites may be done from polymeric pitches (tar) (poly volatile, epoxies, epoxy phenols and so on) and thermoplastics (polyethylene, polyvinyl chloride, capron and so on). The choice of matrix type is dependent from exploitation conditions and required physical mechanical properties.

According of method of forming the composites may be obtained by laying out, reeling, pultrusion, pressing and so on.

According of geometry the composites may be consist of small dispersion (various powder, cut fibres, crystals and so on), fibres matrix (needles of different density, plaits, tapes), woven materials (fabrics of various weaving, canvas and so on).

Composites may be divided for 1) forced; 2) non-forced; 3) special.

For 1) it is necessary to have high strength and stiffness of material with purpose to obtain safety exploitation under high loading.

For 2) this are composites, low loaded mechanically – this are various types of barrier, shields, covering and so on.

The wide application of special composites is found, for example under high temperature there are carbon - carbon materials, for radio - technics- magneto dielectrics and so on.

Physical Mechanical Properties of Composites

Comparative analysis of various composites shows that the characteristics (strength, and sometimes stiffness) have evident advantage.

The largest composite in use is glass plastics, because they are cheap, accessible raw materials, have simple technological process and wide association. This advantage, compared with glass fibers, is stimulated not only by high elastic modules, but by less density. That is very important for space technics.

The second is organ plastics with high strength for tension and compression as well as high plastic modules.

The wide application of boro plastics is impossible, because, they are very expensive and complicated to be produced.

The most prospective composite is carbon plastics. Its production is increasing and its price is decreasing. It has a great strength and stiffness, with even higher elastic modules.

Conclusions

1. The wide application of composites is being kept back by not enough knowledge about influence of external reasons for capacity composite constructions That is why the main problem in the nearest years will be increasing the exploitation safety and capacity for composites with polymer matrix under various factors (temperature, dampness, atmosphere electricity, solar radiation, fuel, chemical medium, erosion, burning and so on).

2. The serious brake to apply the composites in industry is their high price, that is why the main branches for its using will be aircraft, rocket and space industry.

3. The design and learning the poly armour composites with wide diapason characteristics essentially within the region their application.

4. The perspective of application of composite with metal matrix is determinate only for boro- aluminum- strengthening laps in construction heave loaded parts of aircrafts, blades the first step of compressor.

5. The combined armour is applied for composites with metal matrix (bor, aluminum and carbon with additional armour with titanium foil) for obtaining the wider spector of characteristics.

6. In the nearest year it is waited to obtain of liquid phase methods of preparing of composites with metal matrix, and also of continuous casting of armored elements. These methods are comparatively universal and allow to obtain various composites contractual (carbon-bor-aluminum) antifriction (Pb-Sn, Cu-Su and other with carbon fibre) and co on. Obtaining by casting methods metal composites with polycrystalline fibres from Al_2O_3 has a great interest.

7. The general problem for composites is necessity to creation of engineering methods of calculation part from composites, the creation of indestructible control methods; investigations for capacity of composite elements under exploitation and

climatic factors; stabilization and improvement technology with purpose of reduction of property variation of composites and reduction of labor-consuming character of elements; reduction of prices of armored fibres and composites ; the increasing exploitation safety, by means of increasing strength on the division board of the composite components.

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Kravtsov M.K., Obolenskaya T.A., Beletskaya I.V. “Ways to increase the durability of materials in modern mechanical engineering”.

The article describes the scope, classification, physical and mechanical properties composites, the problem of using composite materials in modern mechanical engineering.

Key words: composites, construction materials.

Кравцов М.К., Оболенська Т.О., Білецька І.В. «Шляхи підвищення довговічності матеріалів в сучасному машинобудуванні».

У статті розглянута область застосування, класифікація, фізико-механічні властивості композитів, проблема використання композиційних матеріалів у сучасному машинобудуванні.

Ключові слова: композиційні матеріали, конструкційні матеріали.

Кравцов М.К., Оболенская Т.А., Белецкая И.В. «Пути повышения долговечности материалов в современном машиностроении».

В статье рассмотрена область применения, классификация, физико-механические свойства композитов, проблема использования композиционных материалов в современном машиностроении.

Ключевые слова: композиционные материалы, конструкционные материалы.

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