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In Article pryvedenы proposals for calculating prochnosty stalefybrobetonnыh pipes and evaluation of stress-deformyrovannoe STATUS pryamouholnыh Széchenyi fybrobetonnыh elements based on Prandtl dyahrammы.

Prochnost, element, armyrovanyya, basalt, Fibro.

The paper presents suggestions for calculating strength steel fiber-reinforced pipes and evaluation of stress-strain state of rectangular sections fiber concretes elements based on Prandtl chart.

Strength, element, reinforcement, basalt, fiber.

UDC 630.56.7

QUALITY STEEL
By optimizing CONTENT REM

OE Semenov, Ph.D.

The effect of non-metallic inclusions in steel structure morphology. Past studies of mechanical properties and microstructure of steels with REM. The optimal concentration of cerium in steel.

Model, property, steel alloying.

Problem. The most important direction in solving problems of improving the design of vehicles, reducing their metalomistkosti while increasing reliability and durability are improving the quality of the metal. Mikrosklad alloy determined by the degree of purity, shape and composition nemetelevyh inclusions. These factors significantly affect the nature of crystallization, morphology, composition and structure of grain boundaries and adjacent areas that define a range of technical and operational properties.

To address the problems at work, consider the impact of these alloying elements on the operational and technological properties of steel, depending on bahatokomponentnosti doped and conditions of structure formation.

Analysis of recent research. Non-metallic inclusions have a decisive influence on the mechanical and performance properties of steels. So the authors of [1] has improved by two orders of durable materials for rolling bearings when tested in cyclic fatigue by reducing the content in steel-metallic inclusions. Steel, in general, it is proposed to consider a multiphase composite material, the metallic matrix in which the proportion of non-distributed phase [1, 2]. Properties such a conglomerate depend on the nature of the interaction of non-metallic phase matrix. They are defined

difference in the mechanical and thermal properties and structure characteristics boundaries combination of structural components. The difference coefficients of thermal expansion of ceramic and metal structural causes of stress in the metal matrix and nonmetallic inclusions, which may increase tensions arising in detail in the application of external loads during operation.

The dependence of the performance of steel on the size and number of inclusions indicates that when the amount of particles in the range of less than 30 microns, no measurable decrease in durability. In the case of larger particles (30 ... 100 mm) wear resistance is reduced to 40 ... 50 per cent of normal life.

One of the most affordable way to reduce the content of non-metallic inclusions in steel and improve their morphology is microalloying steel calcium and breast cancer [2-3].

REM effective additives for grinding and shaping a given structure morphology non phase. They bind oxygen and sulfur compounds in vazhkodysotsiyuyuchi. This completely eliminated the formation of manganese sulphide film that is easily deformed in line at the box office. Reduces the total number of particles that cause cracking. Nonmetallic inclusion in the modified REM and low-carbon steels (with real content of sulfur and oxygen) are mostly one- and two-phase oksysulfidamy REM rounded shape with different ratios of oxygen and sulfur. The melting point of these compounds exceed the melting point of steel. They almost not deformed during rolling. In studies revealed the double effect of additives REM in steel (metal due to quality improvement modyfikuyuvannya and reduce the sulfur content in its remelting). This is typical of a modified REM steel because REM form compounds that contain sulfur, whose presence in the structure of complex alloy improves the mechanical properties of steel. However, these compounds are capable of unauthorized removal of liquid melt. Reduction of sulfur is due to removal (floating) oksysulfidiv REM, which have a lower density than steel and high values of interfacial tension. Resulting in a modified REM pereplavtsi steel desulfurization effect provided high level of mechanical properties.

In [5] found that the overall contamination of the metal oxide inclusions decreases when you enter REM. Experiments were carried out on low carbon steels and 15HSND 10M2S1. It is noted that a change REM phase composition and form inclusions in rolled metal from elongated along the rolling silicates and sulfides, individual particles of aluminum oxide, or their clusters, globular to heterophase inclusions oksysulfidiv and oksysulfosylikativ cerium and lanthanum. The best is Mischmetal additive in an amount of 0.1%, it increases the full range of mechanical properties, especially impact strength, increasing 1.5 ... 2.0 times on samples cut along the rolling direction, and 2, 0 ... 2.5 times a transverse specimens. In addition, a decline of anisotropy properties of steel. REM and positive influence on the propensity of steel to temper brittleness and reverse holodostiykosti. At the optimal content of additives Mischmetal also increases prohartovuvannosti steel.

Reduction of oxygen, sulfide inclusions disappearance plate manganese, cerium sulfide appearance globular shape observed when entering REM in steel 30HHNA [6]. Low carbon steel smelting of rare-earth metals, introduction of additives Mischmetal led to the removal of sulfur and oxygen in the molten slag consisting of oxides and sulfides REM. It is noted that prolonged exposure of steel with REM in the process of melting in the temperature range 1480 ... 1550˚S leads to almost complete removal of sulphides from rare-earth metal. In [7] given data bit opposite nature. The authors note that REM combines with oxygen and sulfur to form inclusions, which migrate to the bottom of the casting.

Optimal amounts of alloying steel ferotseriyu is 0.18 ... 0.20% ferolantanu - 0.10 ... 0.12%. This impact strength steel alloying these limits increases. In addition, REM significantly improve the morphology, size and distribution in the nitride layer consolidated, have catalytic properties in chemical and heat treatment [8], because of their high chemical activity due to electron shell structure - 4-½. However, the complexity of the processes occurring during REM melting steel, requires, in each case, optimizing its chemical composition.

Recent studies have shown that non-metallic inclusions must be treated not just as particles (in terms of mechanics), which have a different structure and physico-mechanical properties, as well as components that interact with a variety of treatments to steel matrix via the interface, which represent independent structural steel component and manifest themselves through various structural effects. Interfaces - non-metallic inclusions steel matrix can be considered as "superficial" phase, which is the active element of structure steel. When exposed to external loads in these boundaries occur transformations that lead to self-organization effects. Experimentally shown [9] that peak thermodynamic parameters and external borders to include matrix dramatically intensify the processes taking place in the steel and cause transformations in these new boundaries. Decisive impact on the full range of service characteristics of steel is the number and morphology of nonmetallic inclusions [10]. From this perspective, the most promising microalloying steel REM.

The purpose of research. To address the problems in the work on optimizing the chemical composition of steel should have a high level of technological characteristics and thus provide the necessary reliability and service life of machine parts, it was necessary to determine the effect of the content of alloying elements in steel structure consolidated and equilibrium, find the correlation ' Connection between microstructure and complex physical, mechanical and technological characteristics of steels. It should be borne in mind that in the core parts after consolidation had to get structure with high viscosity and plasticity with sufficient strength, and the surface of the part martensitic structure should have high hardness, having an adequate supply of specific destruction minimal tendency to nucleation and growth of cracks.

Results. Research conducted in the melting steel 30 kg induction furnace with a basic lining. Charge for steel research consisted of 20 steel, synthetic iron containing 4.40% carbon and appropriate number of ferroalloys. The chemical composition of steels obtained are shown in Table. 1.

1. The chemical composition of the investigated steels.

The content of alloying elements,%											
Number of	C	Si	Mn	Cr	Ni	Those	Nb	Xie	Ca	S	P
1	0.15	0.35	0.99	1.00	1.07	0.03	0.07	-	0,005	0,029	0,028

2	0.15	0.38	1.09	1.07	0.91	0.04	0.06	0,005	0,005	0.019	0,021
3	0.16	0.42	1.08	1.03	1.00	0.04	0.07	0.01	0,005	0.018	0,023
4	0.16	0.43	1.01	1.06	1.10	0.05	0.08	0.02	0,005	0,022	0.020
5	0.15	0.4	1.02	1.05	1.10	0.05	0.06	0,035	0,005	0,026	0,021
6	0.16	0.37	0.96	1.13	1.18	0.04	0.08	0.01	0,005	0,023	0.019
7	0.17	0.39	1.02	0.94	1.08	0.08	0.08	0.01	0,005	0,023	0,021
8	0.17	0.38	1.01	0.97	1.05	0.03	0.07	0.02	0,005	0,023	0,021

As can be seen from the table, the contents of chromium, nickel, manganese, silicon steel research practically unchanged, as is reasonably well understood. This was achieved by using, as a charge, a steel smelting industry. In addition to alloying of steel were used ferroalloys one party. The main attention is paid to the investigation of the influence of the percentage of REM in steel. As the mechanical properties of steel were determined: strength (σ_{to},$\sigma_{0.2}$), Flexibility (δ,ψ), Hardness and impact strength.

The reliability of the results has exceeded 95%. The test results of mechanical properties are shown in Table. 2.

2. The mechanical properties of the steel.

Number swimming trunks	Specifications					
	Yield, σt MPa	Tensile strength, σv, MPa	Vidnosnepodovzhennya, δ,%	Vidnosnezvuzhennya, ψ,%	Udarnav'yazkist, KSU, KDzh / m2	Hardness HRC
1	1171	1298	13	50	1230	43
2	1250	1380	17	54	1330	42
3	1179	1370	18	56	1412	42
4	1181	1330	17	55	1380	41
5	1150	1290	16	53	1180	41
6	1240	1420	17	55	1370	43
7	1210	1390	15	54	1290	44
8	1220	1410	16	54	1290	43

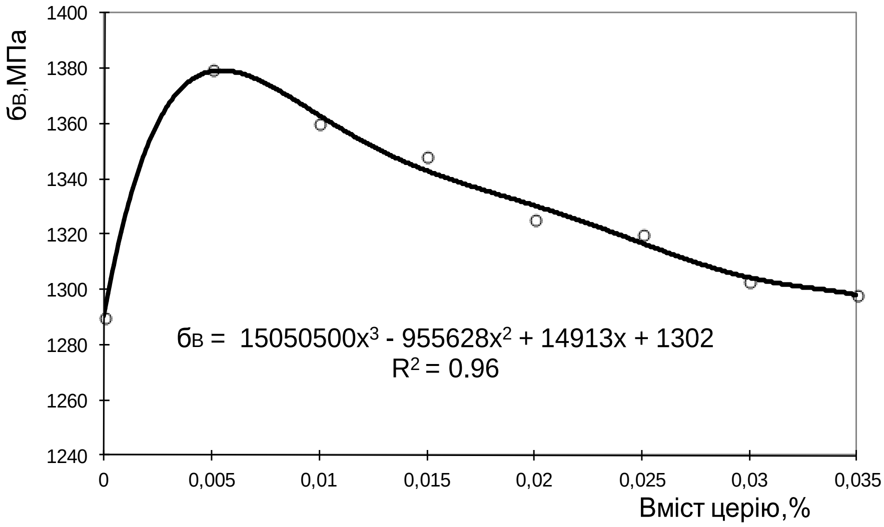

Fig. 1. Effect of Cerium on the strength of steel.

Analyzing the results, we can conclude that microalloying steel such as cerium rare earth metals, ranging from 0.005 to 0.01%, resulting in a greater strength and ductility characteristics (only 0.005% cerium increases the strength of steel at almost 100 MPa). Although it is possible that this is because the cerium doping lowers the content in steel contaminants. Thus there is extreme on the curve of tensile strength steel cerium content within 0,004 ... 0,006% (Fig. 1). A further increase in the doping level of this element (within 0.01 ... 0.02%) leads to a slight (30 ... 40 MPa) drop in strength characteristics, while leaving them at a high level. The introduction of the steel cerium than 0.03%, the impact on the strength of completely leveled. Regarding the influence of cerium on the hardness of steel, we have stable nature of the change of characteristics similar to the changes in strength properties, as evidenced by the data presented in Table. 2. More efficient cerium affects microalloying on the characteristics of viscosity. Yes impact strength steel increased by almost 200 KJ / m2, with cerium content - 0.01% (Fig. 2).

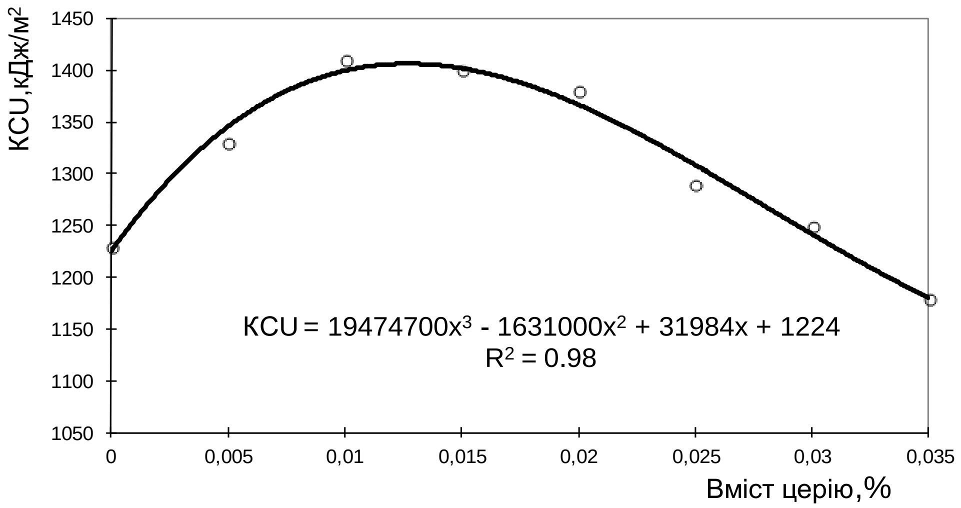

Fig. 2. Effect of Cerium on the toughness of steel.

Depending on the graphics toughness of steel content in it cerium clearly expressed extreme within 0,009 ... 0,012%. Increasing the doping level of this element (above 0,012%), leading to a decrease in the share of destruction, just to change the characteristics of strength. When the concentration of cerium in steel than 0.02% manifested his negative impact on the entire range of mechanical properties.

Analyzing the results of tests conducted to determine the mechanical properties of steel research, it is sufficient degree of confidence to assert that for low-carbon steels cementing based on manganese-chromium-nickel composition is optimal doping of cerium within - 0.005 ... 0.01%. Characteristic of this steel is also i that its structure is not found particles of compounds of rare earth elements. Cerium compounds found in the study of structure steel №5 (Table. 1), alloy within this element to 0.035%. Sulphides of cerium in the steel (chemical composition of which was confirmed by X-ray quality quantitative analysis i) have a size of 10 microns (Fig. 3) that i caused reduction of mechanical properties of steel is especially affected the viscosity characteristics.

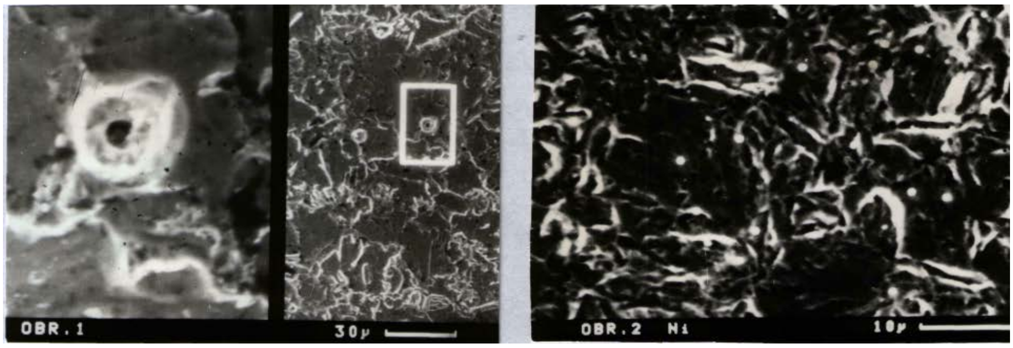

Fig. 3. The inclusion of cerium.

Past studies of the microstructure of steels doped cerium possible to explain the nature of changes in the mechanical properties of alloy compositions investigated. With a slight degree of doping to 0.12, cerium reacts with impurity elements and contributes to refining steel. By increasing its content in the steel structure of metal sulfide inclusion appearing that reduce the full range of mechanical and performance properties.

Conclusions

The results of studies of the effect of doping on the microstructure REM i, as a result, the mechanical properties of the alloy, the following conclusions:

1. Doping steel cerium in small amounts (up 0.01%) increases the toughness of steel.
2. Strength steel intensity increases with the doping of cerium in the range up to 0,004 ... 0,006%.
3. The increase of 0,035% cerium to reduce the mechanical characteristics, so that the structure of steel, grain boundaries appear to include cerium sulfide.

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Yzucheno Effect nemetallycheskyh included in morfolohyyu steel structure. Studies Provedennыe mechanical properties and mykrostrukturы steel with REM. Opredelenы optymalnыe concentrations tseryya in steel.

Model properties, steel alloying.

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Model, property, steel, alloying.