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MAIN CHARACTERISTICS OF MATERIALS USED IN METAL CONSTRUCTION

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Abstract:
This article is on the topic of "the main characteristics of materials used in metal construction", it provides information about the types of metals, their properties and the advantages of metal construction.

Keywords: metals, strength limit, ligering, ferrite, flowability, recovery, load accumulation, QMQ.

Introduction

Since metal is a structural material, it is evaluated based on its mechanical properties, weldability and long-term performance. Steel is determined by its strength, elasticity, plasticity, degree of brittleness, "flowability" at high temperatures. Weldability depends on the chemical composition of steel and its production technology.

The shape of the structure, the types and amount of external influences, the direction and speed of the impact, the level of aggressiveness and temperature of the environment have a great influence on the long-term operation of steel in the structure and its state of strength.

According to strength, steels are divided into three groups:

1) Normal strength Ryn= -185�285 MPa, Run= -365�390 Mpa;

2) High strength Ryn= -295�390 MPa, Run= -430�540 Mpa;

3) High strength Ryn= - 440� ∞ MPa, Run= - 590� ∞ MPa.

The mechanical properties of steels depend on the internal atomic structure. Its basis is formed by particles called ferrite. Ferrite itself has low strength and is a very plastic material. To increase its strength, carbon is added (low-carbon steel) or another metal is added (manganese, silicon, vanadium, chromium, etc.). High-strength steel is obtained by alloying and tempering methods. The atomic structure of low-carbon steel resembles a cube. A carbon atom is located in the center of the cube,

The atomic structure of low-alloy steels is similar to the atomic structure of low-carbon steel.

Let's get acquainted with the chemical elements involved in alloying.

Carbon "U" increases the strength of steel, reduces its plasticity, and reduces the possibility of welding. Therefore, steels used in construction can contain up to 0.22% carbon.

Silicon "S" increases the strength of steel, reduces weldability and reduces corrosion resistance. Therefore, in low-carbon steel it is 0.3%, and in alloy steel it is up to 1%.

Manganese "G" increases the strength and ductility of the metal and combines with sulfur mixed with steel, reducing its harmful effects. However, if the manganese content exceeds 1.5%, there is a risk that the steel will become brittle.

Copper "D" increases strength and corrosion resistance. However, when it exceeds 0.7%, it causes the steel to wear out quickly.

Chromium "X", vanadium "F", tungsten "V", molybdenum "M", titanium "T", nickel "N" - all these increase the strength of steel, and some also increase the plastic properties.

In order to express the chemical composition of different types of steels, the following designation procedure is adopted in GOSTs: The first two numbers indicate the average amount of carbon in hundredths of a percent, and the letters designate the conditional names of the chemical elements that make up the composition of steel. The numbers after the letter indicate the amount of this element in the interest account. If this amount is less than one percent, it will not be shown. When the amount of additional elements included in the composition of steel is less than 0.3%, they are not indicated in the symbol.

Steels used for construction structures must be strong and weldable, as well as resistant to erosion and dynamic effects, that is, the construction of such devices mainly requires steel of the "V" group, VSt3kp2-welded steel (kp-welded, sp-quiet steel, ps-semi-quiet steel). There are two ways to melt steel. With the introduction of oxygen in Marten furnaces and by the convector method. There are two main ways to increase the strength of steel: high temperature treatment and alloying. The main purpose of high temperature treatment is to change the atomic structure of the steel and grind its particles.

As a result of this process, the strength and yield strength of steel increases with a slight decrease in elasticity. The main types of high temperature treatment are: tempering, normalizing and tempering.

Annealing consists of heating the steel to above 9100C and then rapidly cooling it. In normalizing, rolled steel is reheated to the temperature at which the austenite structure is formed, and then cooled in air. As a result of normalization, the structure of steel improves significantly, internal stresses disappear, which, in turn, leads to an increase in the strength and plastic properties of steel, resistance to impact. Annealing consists of heating the steel to a temperature above the austenite transformation temperature (2730C) and then cooling (in air or water). In this case, the brittleness of steel decreases and its impact resistance increases.

Fundamentals of designing metal structures. The design of construction structures means the calculation and design of their static (or dynamic) forces, the cross-sectional surface of the element.

In general, the calculation of building structures consists of two stages:

1. Determining the tension in the elements and finding the cross-section surface based on this tension;
2. Check that the bending of the structure does not exceed the norm.

The effectiveness of the designed constructions is evaluated depending on their technical and economic indicators and the level of compliance with the existing usage requirements during operation.

Concrete is the most widely used construction material. The price of concrete is much cheaper than other materials. Because its mechanical properties are much different than those of steel. In this case, there is no material equivalent to concrete. It includes materials that are available everywhere. Another positive aspect is that the strength of concrete increases from year to year. This feature shows that reinforced concrete structures are durable for a long time. Not to mention the architectural and constructive possibilities of concrete.

The main purpose of the calculation is to choose the most economical dimensions of reinforced concrete structures when working under load, and at the same time to achieve safety, reliability and durability requirements.

The main task of the calculation is to determine the stresses generated in the structural elements due to the external load, to determine the required cross-sectional surfaces, the amount of reinforcements, and the necessary information for the preparation of construction working drawings. Calculation of the structure is carried out based on the requirements of the building codes. Construction standards and regulations are considered the practical result of the theory of construction constructions of QMQ and it reflects the progress achieved in the design, construction and operation of structures. The cross-sectional surface, which takes into account the effective shape and dimensions of the normal cross-sectional surface of the element, the optimal class of concrete, the class of working reinforcement, the cross-sectional surface, and the crack resistance and toughness of the element, is called the calculated cross-sectional surface. A construction is understood as combining parts of an element. Designing consists of structural solution of buildings, determination of the effective scheme of placement of working and installation fittings from their elements, development of drawings of construction units and elements of formwork and fittings. On the basis of information about the construction design, cross-sectional surface, taking into account the standard requirements, it is necessary to determine the calculated strength that ensures the strength, crack resistance and integrity of the building and the building during its construction and use.

Requirements for building constructions. Construction structures are designed taking into account functional, technical, economic, aesthetic and other requirements.

According to the functional requirements, each structure should be suitable for the purpose it is intended for and should ensure the convenience and safety of the technological processes carried out in the building or structure.

Technical requirements are aimed at ensuring the necessary strength, integrity and durability of the structure.

Important requirements for construction structures include cost-effectiveness, industrialization and technology in preparation and use.

Prefabricated structures consisting of elements prepared in factories fully satisfy these requirements.

Economic requirements greatly influence the choice of construction material, its type (for example, trusses or beams) and basic dimensions (for example, beam height).

Constructive solutions should be chosen based on technical-economic expediency of using constructions under certain conditions, taking into account the maximum reduction of material and energy consumption, as well as labor intensity and the cost of the construction object. This can be achieved by:

- use of effective building materials and constructions;
- reducing the mass of constructions;
- full use of physical and mechanical properties of materials;
- use of local building materials;
- compliance with the relevant requirements regarding the economical use of the main building materials.

In the design, several options for solutions are created, in which indicators related to materials, energy, labor consumption, construction costs and terms are determined in the preparation and construction of constructions; the architectural appearance of the structure is also taken into account. By comparing options, the most optimal solution is selected.

Economy of constructions is one of the main requirements for them. Cost-effectiveness depends on the consumption and cost of materials, preparation of constructions, transportation to the construction site, installation and their use.

In terms of material consumption, the most preferred construction is the construction of equal strength. All cross-sections in such a structure are selected under the condition of full use of the physico-mechanical properties of the materials used for it (in structures with unequal strength, the strength of some large elements is not fully used).

The structure must be designed for the forces acting on it. External loads, displacement of supports, temperature changes, penetrations and other similar phenomena are among the forces acting on structures.

Constructive schemes should be drawn up when designing buildings and structures. Such schemes should ensure the necessary strength and priority of constructions in all parts of the building and structure, at all stages of its construction and use. In the projects, it is necessary to take into account measures aimed at ensuring the long-term durability of structures, to choose cold-resistant and fire-resistant, corrosion-resistant materials, and to take measures to protect them from rotting.

Loads and effects on metal structures. Depending on the time of exposure, loads can be permanent and temporary, i.e. temporary, temporary can be long-term, short-term and individual.

Loads that are permanently exposed include:

a) the weight of building parts, the weight of load-bearing and blocking construction structures;

b) weight and pressure of soils (uplift, filling), mountain pressure. Stresses from pre-induced stresses in structures or floors are considered in the calculations in the same way as stresses from permanent loads.

Loads that have a long-term effect on time include:

a) the weight of the curtain that temporarily separates the rooms;

b) fixed equipment machines, devices, motors, containers, pipes, belt conveyors, conveyors, fixed lifting machines, as well as the weight of liquids or solids filling the equipment;

c) pressure of gas, liquid and scattered bodies in vessels or pipes, excess pressure created by ventilation of air in mines;

g) the weight of items to be placed on the roof of warehouses, ice houses, grain storage, book storage rooms, archives and similar buildings or placed on shelves;

d) technological effects from the temperature falling from stationary equipment;

e) weight of water layer on flat roofs filled with water;

j) weight of accumulated production dust layer;

z) loads of people, animals, and equipment falling on the roofs of residential, public, and agricultural buildings, with a reduced standard value, given in Table 3 of QMQ 2.01.07-96;

i) vertical loads caused by bridges and overhead cranes with reduced standard values; to determine this, the full nominal value of the vertical load generated by one crane is multiplied by the following coefficients at each interval;

-0.5 for 4K-6K group taps operation mode; 0.6 for 7K group taps mode; 0.7 for 8K group taps mode;

k) snow load with reduced standard value; to determine this, the full normative value is multiplied by a coefficient, 100kg/m2 x 0.3; 150 kg/m2 x 0.5; 200 kg/m2 x 0.6;

d) effects resulting from ground deformations, not related to the fundamental change of ground structure or melting of permafrost;

m) effects caused by changes in the humidity of materials, sitting and aging.

Temporary short-term loads include:

a) loads arising during equipment start-up and stop, testing, moving or replacement;

b) the weight of people and materials used in the repair of equipment;

c) loads with a full standard value from people, animals and equipment on the roofs of residential, public, agricultural buildings;

g) loads from moving lifting vehicles (loaders, electric cars, loader cranes, hoists, as well as loads with a full standard value from bridge and overhead cranes);

d) snow loads with full standard value;

e) climate effect of temperature with full normative value; j) wind loads;

z) luggage cargo;

Special cargo includes:

a) seismic effects;

b) explosion effects;

c) loads arising as a result of sudden changes in the technological process, temporary failure or breakage of equipment;

g) effects caused by deformations in the ground as a result of sudden changes in soil structure (when subsiding soils are wetted) or subsidence in the area of mining deposits.

Load total. A structure is usually subjected to a combination of several different loads, but it is unlikely that all available loads will act on the structure at the same time. Therefore, when calculating structures and floors according to the first and second groups of limit states, it is necessary to take into account the most insignificant sums of loads and corresponding stresses.

These sums are determined by considering the possibility of different patterns of simultaneous application of temporary loads to the structure or the ground by considering different loads acting in different variants or the absence of some loads.

Depending on the content of the loads to be taken into account, the aggregates are divided into the following types:

a) main aggregates consisting of permanent, long-term and short-term loads;

b) special aggregates consisting of permanent long-term, short-term and special loads.

When temporary loads with two different normative values are included in the total, its smaller normative value is considered as a long-term burden, and its larger normative value is considered as a short-term burden when taking into account its full normative value.

If the composition of the main aggregate consists of a permanent load and one temporary (long or short-term) load, it is not multiplied by ps1, ps2 coefficients.

Note: If the composition of the main aggregates consists of three or more short-term loads, their calculated values are multiplied by the aggregation coefficient ps2; where the value of the coefficient (according to importance) is taken for the first short-term load - 1.0, for the second - 0.8, for the rest - 0.6.

The probability of joint exposure is found by analyzing the available options. The effects of combined loads mainly include permanent, temporary, long-term and short-term loads. The effects of separate combined loads include permanent, temporary, long and short-term and one special load.

Performance of steel under static load. Steel mainly consists of ferrite and pearlite particles. Perlite particles are stronger. The strength, elasticity and workability of steel, which is mainly composed of two types of particles, depends on their proportions. Performance of monocrystalline iron. Theoretical and experimental studies show that it is easier to move a piece of monocrystalline iron than to break it. Therefore, elastic deformations are established by displacement in iron particles. On the basis of experimental investigations, it is concluded that the displacement is in a large diagonal direction over the planes.

Knowing the strength of interatomic bonds, it is possible to make an approximate theoretical calculation. The force of atomic crystals lying in one plane to move atomic crystals lying in another plane is a hundred times less than the theoretical calculation. The difference between theory and practice can be explained as follows: because the bonds in the atomic structure are not at the ideal level (due to the presence of flaws, (defects)).

There are two ways to increase the strength of materials:

1. Reducing defects in the crystal structure, bringing them closer to the ideal structure;
2. Bonding of atoms can be achieved by changing its crystal lattice.

The diagram of stresses in the structure of steels is depicted in Fig. 2.1. For example, let's analyze the elongation diagram of carbon steel St3.

After the yield point, the resistance of the material begins to increase, that is, the material becomes stronger. This indicates that perlite particles with higher strength and uniformity have been activated. This stage of steel work is called the self-hardening stage. After the stress value equals the temporary resistance (strength limit), the "neck" becomes thinner and the sample breaks quickly.

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