Microscopic Evaluation of Cast Iron with Flake Shape of Graphite

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This paper deals with investigation of vibration damping properties of grey iron by means of modal analysis in SolidWorks software environment. Modal analysis is accompanied by material study of metal matrix and graphite particles evaluation. Grey iron is one of the most used cast materials, in relation to good damping properties and high pressure strength. To obtain the required mechanical properties it is necessary that the graphitic particles be evenly distributed in the metal matrix and had the optimum size and shape. Flake shape of graphite decrease tensile strength of grey iron, but a suitable method of inoculation, it can cause an increase of tensile strength up to 350 MPa. Flake shape of graphite particles increases the thermal conductivity. Grey iron is material with used in the manufacture of heavy machine stands, pump bodies and low-stressed sliding bearings in the context of with its characteristic material properties.

Keywords: Cast iron, Flake graphite, Microstructure, Finite element methods,
At 1000-fold magnification, very fine flake graphite was observed (Fig. 3). The cast iron matrix consists of a lamellar perlite structure with no visible presence of ferrite grains, which corresponds to a 98% perlite content (Fig. 4). The high content of the perlite structure is likely to be associated with a higher rate of cooling, which was also shown in the fine grain structure [6]. The average distance between cementite lamellas in perlite grains is 131.63 nm (Fig. 5). Small distance of cementite lamellas is associated with increasing values of strength and hardness of cast iron at the expense of decreasing ductile properties, such as ductility and contraction [7]. This structure occurring over the whole casting volume, provides increasing of abrasion resistance and mechanical properties (Rm, HB), and also improves corrosion resistance [2].

The occurrence of other structural phases and components was not observed. In terms of the presence of non-metallic inclusions in the material structure, mainly titanium carbonitrides were observed, the occurrence of which was rare. The size of these inclusions was 5 µm or less (Fig. 6). The mechanical properties of the cast iron structure can be increased by alloying [8]. Main alloying elements are, in particular, chromium, vanadium, molybdenum, copper, nickel or tin. Less frequently used are aluminum, titanium or other elements.
3 Experimental modal analysis

An important factor in the oscillation of construction materials is their own shapes and frequencies [9]. Modal analysis and the associated determination of basic dynamic characteristics is a fundamental step in dynamic calculations [10]. In the use of FEM (Finite Element Method), a discrete system is used, which is characterized by discrete mass points and their corresponding rigidity. The sample calculation model was created under the standard [11]. The analysis of the homogeneous strength and damping beam (Tab.1) sample was carried out using the finite element method in the SolidWorks software environment (Fig. 7). The input material parameters of gray graphite cast iron were defined with respect to the fact that the elastic modulus E is closely related to the structure (strength, hardness). The higher the strength and hardness, the greater the elastic modulus [12].

| Eigenshapes | Frequency |
|-------------|-----------|
| a           | 51.31 Hz  |
| b           | 321.24 Hz |
| c           | 336.69 Hz |
| d           | 898.66 Hz |

4 Conclusions

Nowadays, graphitic cast iron, especially gray cast iron and spheroidal graphite cast iron, predominate on the market, which is also proven by their production volume. Modal analysis is an area of research that combines signal processing and computing interaction, theory of mechanics, oscillation, acoustics, applied mathematics and engineering prediction. Internal damping occurs in the material structure and may be due to its imperfection. Therefore, in this view it is also essential to know the particular material before introducing it into service.

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Fig. 6 Titanium carbonitride, Nital

Fig. 7 The first four eigenshapatess and the inherent frequencies of the homogeneous beam

Tab. IEigenshapes and eigenfrequencies

| Eigenshapes | Frequency |
|-------------|-----------|
| a           | 51.31 Hz  |
| b           | 321.24 Hz |
| c           | 336.69 Hz |
| d           | 898.66 Hz |
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