Analysis of the Machinability of Different Grades of Cast Iron

Urinov Nasillo Fayzilloevich	Candidate of technical sciences, associated professor Bukhara Engineering-Technological Institute
Saidova Mukhabbat Khamroevna	Senior Teacher Bukhara Engineering-Technological Institute
Mukhammedov Mekhriddin Beshimovich	Undergraduate Bukhara Engineering-Technological Institute

ABSTRACT

The article discusses the problems that arise during the machining of cast iron and analyzes them.

Keywords: Cast iron, lamellar graphite, ferrite, chips, cutting speeds, feed, tool, chip formation.

Cast iron with plate graphite has very good properties for machining. The main reason for the continued large-scale use of cast iron in mechanical engineering is not only the low cost of the material and the casting process, but also the low cost of the finally processed product [1]. By almost all criteria, it has good machinability – low tool wear speed, high metal removal speed, relatively low cutting forces and cutting power. The surface of treated cast iron, rather matte in appearance, is, however, ideal for many sliding surfaces. The chips obtained during processing come off in the form of very small particles, the removal of which from the cutting zone can be easily carried out even when processing with high cutting speeds. Cast iron processing is to some extent a dirty and dusty operation associated with the presence of fine graphite dust in the air, which requires the application of certain measures to protect the operator.

Like the processing of other materials, cast iron processing is characterized by a large difference in the behavior of cast iron when cut in the shear plane and on the interface of the tool and workpiece. The most important feature is that the disruption in the shear plane occurs at a very high frequency caused by the presence of lamellar graphite. This leads to the formation of chips consisting of very small particles only a few millimeters long. Due to the fact that the chips are not draining, the length of the contact on the front surface is very small, the chips are thin and the cutting forces and power expended are low.

The small cutting force is also explained by the fact that the graphite plates have low strength and a relatively large size, so that one plate can overlap almost the entire shear plane. In Table. Figure 1 shows the values of the cutting forces F_c (P_z) and the feed f (P_x) for a typical perlite cast iron compared to steel in the same cutting modes. This aspect of machinability is affected by the grade and composition of cast iron. Low-strength cast irons, whose structure consists mainly of ferrite and graphite, are the most well machined, allowing the highest metal removal speeds.

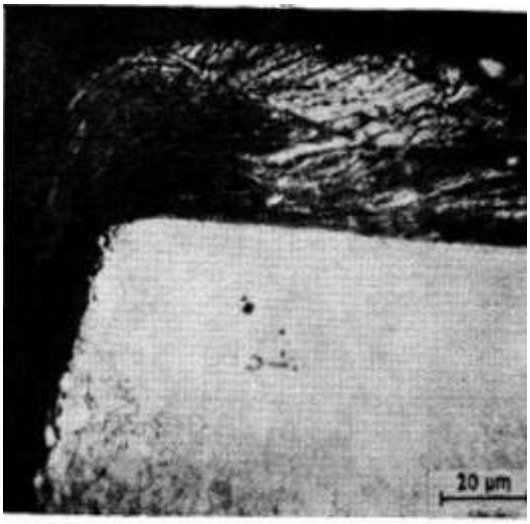
Table 1 – Cutting *forces* F_c (**Pz**) and feed *forces* F (P_x) (H) when machining perlite cast iron with plate graphite (feed 0.16 mm/v, cutting depth 1.25 mm)

Cutting speed m/min	Cast iron		Carbon steel	
	F	Fff	Fc	Fff
30	2 32	232	520	356
61	2 45	285	490	364
91	2 45	320	445	325
122	2 67	338	422	313

Allowable cutting and feeding speeds are somewhat lower for perlite cast iron and decrease with increasing strength and hardness. High-alloy and bleached cast iron with a very low graphite content and a high content of iron carbide Fe_3C and carbides of other metals are very difficult to machine. Rolls of bleached cast iron can be processed with hard alloy tools at a speed of 3-10 m / min.

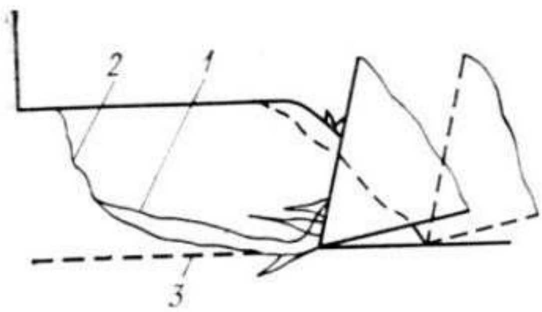
The nature of the deformation of most structural cast irons (ferritic or perlite type) during their processing by cutting can be determined with sufficient accuracy in advance on the basis of data on their strength and ductility obtained during standard mechanical tests in the laboratory. However, their behavior on the surface of the tool-blank section is less "standard". One would expect graphite to act as a lubricant and prevent adhesion on the surface of the tool-workpiece section, but there is no evidence to suggest that it acts in this way. Machining with tools made of hard alloy or high-speed steel produces a growth that persists at a higher cutting speed than when machining steel. Perlite cast iron machinability maps with a WC-Co-based carbide tool (VK group) show the area in which the growth is preserved. As the cutting and feeding speeds increase, the shape of the growth changes, and eventually the growth disappears when a wear hole appears on the tool. Figure 2.5 shows a cross-section of the growth interlocked to the front surface and worn back surface. It consists of dispersed particles of the metal base of cast iron, extremely strongly plastically deformed and welded together; cementite and other structural constituents are usually so strongly dispersed that they cannot be seen in an optical microscope. In the growth, graphite is not detected - in the upper part, the structure of the growth is in a polished, but untreated grind. Apparently, graphite is present in the form of separate very thin layers, since when the growth is dissolved, a black precipitate forms in the acid.

Thus, under the influence of compression stresses under conditions of plastic deformations on the surface of the tool, ferritic and perlite gray cast irons on plate graphite behave like plastic materials. Therefore, the feed force F_f is often higher than the cutting force F_c (as can be seen from Table 1) and closer to the value F_s when processing steel. Usually, the processing of cast iron with tools from high-speed steel or from a hard alloy is carried out in modes in which a growth is formed and a sufficiently high resistance of the tool can be ensured. When a chip is formed, the growth is more stable and less often separated from the tool even in conditions of intermittent cutting. Tool wear is mainly determined by adhesive processes, and the greatest tool durability can be achieved by using tools made of wolf-scaleobalt alloy with highly dispersed carbide particles. At a higher metal removal rate, the growth disappears, and to reduce the rate of formation of the wear well and diffusion wear of the back surface, tools made of a hard alloy having dispersed grains of carbides and containing a small amount of TiC and TaC are used. TiC coated tools can also be used to reduce the rate of wear.



Rice. 1. – Cross-section on the growth on a carbide tool after machining by cutting gray cast iron with plate graphite.

Studies so far have suggested that the temperature distribution of tools in cast iron processing is different from the temperature distribution in steel processing. When chips other than drain chips are formed, the highest temperature is observed near the cutting edge. In the presence of both high compression and temperature stresses in this zone, the upper limit of the metal removal rate is limited by the deformation of the cutting edge Fig. 2. Mineral-ceramic tools, which have a very high wear resistance under conditions of diffusion wear and high heat resistance, can be used to process perlite cast iron with plate graphite at a cutting speed of over 700 m / min compared to a maximum speed of about 180 m / min allowed by carbide metal-ceramic tools.



Rice. 2 – Scheme of chip formation of fragile materials. 1 and 2 – crack surfaces when separating chip elements; 3 – theoretical surface of the cut.

Globular graphite cast irons, which have better mechanical properties [2,3] than lamellar graphite cast iron, have recently replaced them in many cases. In cast irons with spherical graphite, the latter is present in the form of small spheres, not plates, but when processed, cast iron with spherical graphite behaves like cast iron with plate graphite and can be processed in most cases using the same technology.

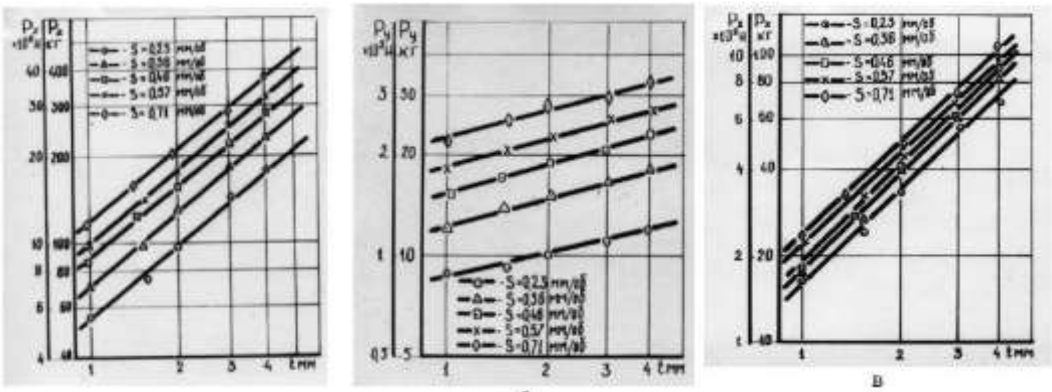
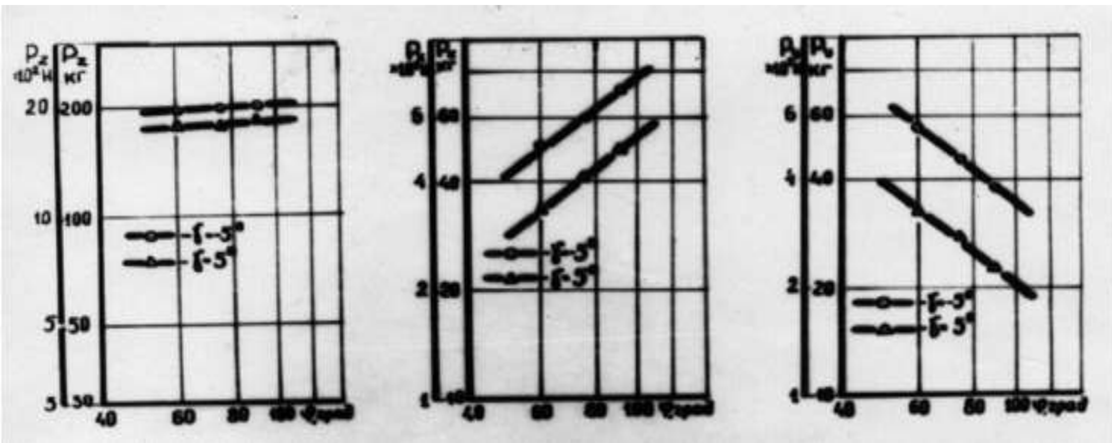
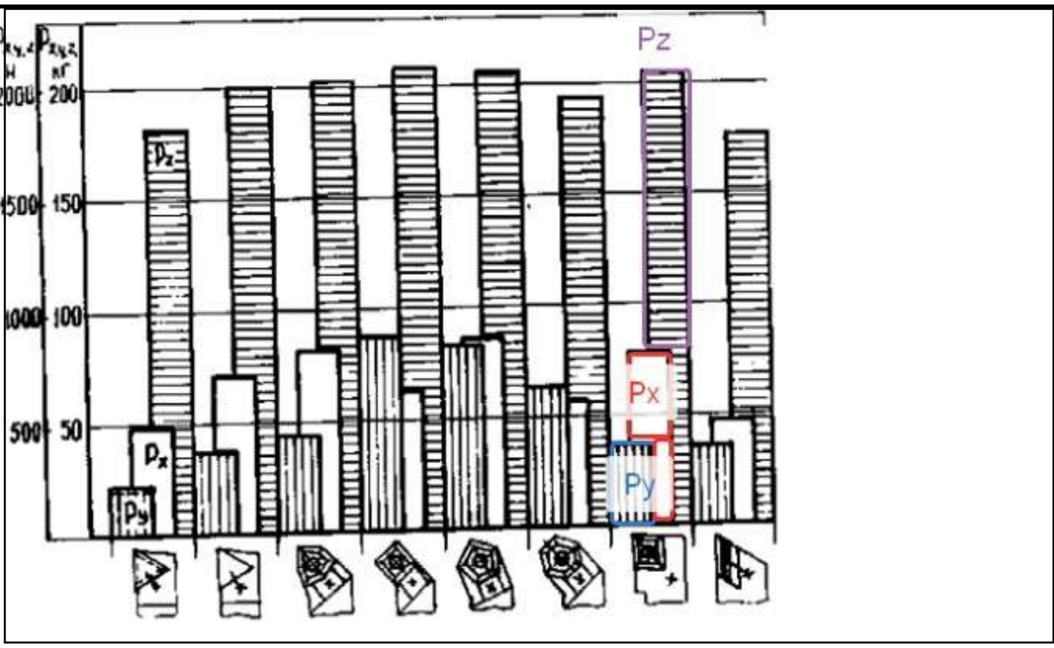


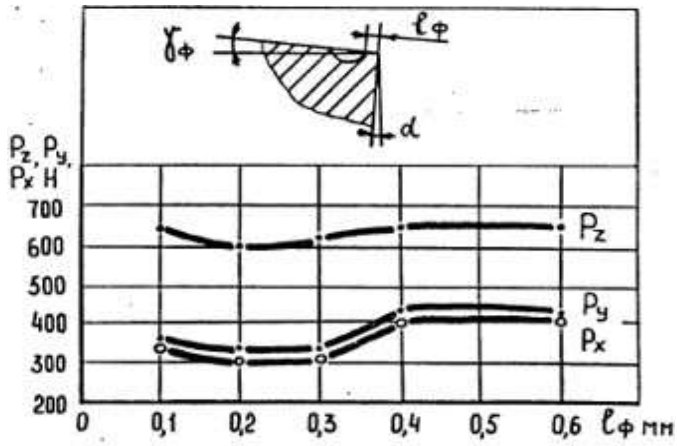
Fig. 3 – Influence of cutting and feeding depth on components *Pz* (a), *Py* (b), *Px* (c) SCH25-VK6; cutter - VA3, triangular plate with a rear angle of α = 7º, *v* = 1.0 m / s



Rice. 4 – Influence of the angles in the plan and the front cutter on the components of the cutting force. SCH25 - BK6; VAZ cutter, triangular plate, *v*=1.0 m/s, *t*=2 mm, *s*=0.57 mm/rev.



Rice. 5 – Influence of the shape of the polyhedral plate on the components of the cutting force [4] SCH25-VK6, v=1.0 m/s, t=2 mm, s=0.57 mm/v. t=2 mm, s=0.57 mm/v → qPz= 1842 N/mm^2; qPx= 702 N/^{mm2}; qP= 263 N/mm^2;qPhu= 750 N/mm^2; μav= 0.41. When planing cast iron b= 8 mm, t = 1 mm → P_Z = 14736 N / mm^2, μsr = 0.41, Phu = 6042 N / mm^2.



Rice. 6 – Influence of the width of the chamfer on the front surface on the value of the components of the cutting force, t=1 mm, s=0.3 mm/v.

Globular graphite reduces the strength of the material in the shear plane and contributes to its destruction, but in this respect it is much less effective than plate graphite. The resulting chips are very long segments, which, however, are fragile and easily destroyed, resembling more shavings of lamellar graphite than steel.

Figures 3-6 show the effect of various parameters on the components of the cutting force during cast iron processing.

One of the problems that sometimes arises when processing ferritic cast iron with spherical graphite is that the material in the plastic flow zone is extremely plastic and can stick to the back surface of the tool when processed at high cutting speeds, causing very large cutting forces, high temperature and leading to poor processing quality. This problem can be largely solved by providing a large back angle on the tools.

Literature

1. Bobrov V.F. Osnovy teorii cutting metals. M.: Mashinostroenie,1975.344s.
2. Production and properties of cast iron with spherical graphite. Edited by Girshovich N.G. - M., L.: Leningrad branch of Mashgiz, 1962, - 351 p.
3. Kuznetsov B.L. Introduction to the foundry metallovoedema cast iron. M: Mashinostroenie, 1995. - 168 p.: ill. /ISBN 5-217-02742-8
4. Petrushin S.I., Grubny S.V. Processing of cast irons and steels with prefabricated cutters with interchangeable polyhedral plates. – Tomsk: izd. TPU.2000. – 156 s