Improving the surface finish in high speed milling of stamping dies

Luis N. López de Lacalle a,*, A. Lamikiz a, J.A. Sánchez a, J.L. Arana b

a Department of Mechanical Engineering, University of the Basque Country, Escuela Tecnica Superior de Ingenieros Industriales, c/Alameda de Urquijo s/n, E-48013 Bilbao, Spain
b Department of Metallurgy and Materials Science, University of the Basque Country, Escuela Tecnica Superior de Ingenieros Industriales, c/Alameda de Urquijo s/n, E-48013 Bilbao, Spain

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Abstract

The high speed milling (HSM) of GG25 grey iron castings and GGG70L ductile iron casting stamping dies has proved its feasibility when it comes to finishing operations, giving an important cost reduction when compared with traditional manual polishing associated with conventional milling. However, a number of problems still remain unresolved, improvements in these subjects will undoubtedly lead to an optimum machining situation.

In this paper, a systematic description of the main industrial problems is given, as a major step towards a stable and optimum industrial application of this technique. Thus, an important part of the study is devoted to the optimisation of tools to be used, from the point of view of their geometry, base material and coatings. Testing has been carried out using coated carbide tools and PCBN (polycrystalline cubic boron nitride) tools. The importance of the use of optimum machining strategies for roughing and finishing operations of stamping dies is then analysed. Finally, the problem of tool deflection when machining deep cavities is studied.

Keywords: High speed machining; Iron castings; Dies; Milling

1. Introduction

Stamping die manufacturers all around the world (and especially, those in Japan, USA and Germany) have included high speed milling (HSM) in their production, aiming to reduce production costs and times. Spanish manufacturers are currently following that trend. However, clear differences can be noticed between Japan industries and the rest. Thus, the lead time in the Japan industry is about 10 weeks, whereas in the case of European and American manufacturers, the lead time is about 20 weeks [1]. About 65% of the total manufacturing time is spent in machining and polishing operations. There are many factors that can explain this difference, amongst which the following must be highlighted: higher product requirements in the case of European and American manufacturers, the reduction of non-productive operations and the extended application of HSM in the case of the Japan industry.

The main goal of HSM when applied to the finishing operations of moulds and dies is the reduction of the maximum surface roughness down to 10 μm or even less [1,2] always taking into account that an agreement must be achieved between machining times (and therefore, cost per hour of the machine) and the final surface finish of the component. Due to the fact that the feed rate can be 5–10 times that of conventional machining, it becomes possible to increase by the same factor the number of passes. As a consequence, the surface finish is greatly improved, reducing manual polishing, that may account for up to 30% of the total time spent in the die manufacturing process. Spanish stamping die manufacturers are not an exception, their objective being the improvement in surface finish [3]. A Spanish leading stamping die manufacturer has estimated the reduction in times and costs that result after the application of HSM. These data can be found in Table 1. It can be seen that the time related to manual polishing is clearly reduced, although in contrast, an important effort has still to be done in CAM programs preparation.

However, the successful application of HSM is still limited by a number of problems related to the optimum tool selection [4], the machining strategies [5] and the CAM programming. In this paper, a set of milling tests are analysed, and some conclusions are obtained for a right application of HSM to die manufacturing.