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MODELLING OF MILLING TOOLS IN THE PROCESSION OF ROAD AND RAILWAY INFRASTRUCTURE FACILITIES

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Abstract

The requirements for procession of road and railway infrastructure facilities have conditioned the need for design of appropriate milling tools. It means that a milling system should be able to process different materials according to a given profile. Therefore, there appears a need for variant and parameter design of families of milling tools, which is accomplished by application and integration of different CAx tools.

Keywords: infrastructure facilities, milling tools, CAx tools.

1 Introduction

Milling tool systems have a broad range of application, which means that designers of these systems are faced with the requirements of machining the surface which, in most cases, is not homogeneous and consists of several types of materials. Besides, there are characteristic requirements regarding the shape of the profile being machined and the required quality of the machined surface, which additionally imposes a need for variant and parameter design of cutting subassemblies.
Product design in a virtual environment is one of key conditions that influence the reduction of costs generated in engineering design processes during the product life. The CAD designed components are joined in subassemblies and assemblies in the CAA environment at the local and global levels. Then it is necessary to perform a conceptual analysis of variant generated and designed subassemblies as well as maximum utilization of typified and unified components and subassemblies.

2 Types of milling tools in the processing of infrastructure facilities

Specification of functional requirements from the aspects of types of surfaces, hardness and composition of the material being processed imposes the need for designing a system of milling tools with different shapes of drums, milling heads, cutting wheels and pick bodies [2]. Taking this fact into account, milling tool systems can be classified in three groups as follows:

1 milling drums,
2 milling heads, and
3 cutting wheels.

2.1 Milling drums

Milling drums presented in Figure 1 are the systems mainly used for procession of road infrastructure facilities, for removal of damaged layers of asphalt. They represent a cutting subsystem of road milling machines and may be of various widths depending on the size of road milling machines in which they are installed. [1]

Figure 1 Milling drums

The main elements of milling drums are the drum and the picks properly arranged along the brim of the drum. They are presented in Figure 2.

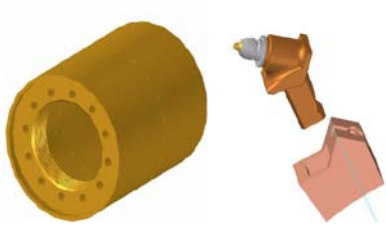

Figure 2 Milling drum and the pick with a holder

2.2 Milling heads

Milling heads represent attachments in dredges. Today, in Serbia, construction of tunnels plays an important role in the development of infrastructure of transportation systems. There is a great need for construction of new tunnels and widening of the existing ones. The ongoing jobs are those relating to widening and reinforcement of the existing tunnels, Figure 3. [5]

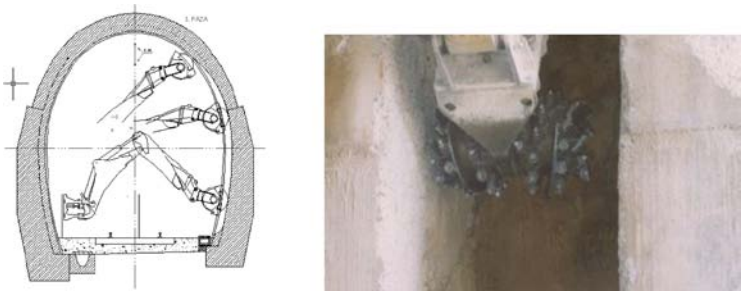

Figure 3 Milling heads in the procession of tunnel profiles

The main elements of milling head systems are milling heads, power transmitter, casing and hydromotor, and some of them are presented in Figure 4.

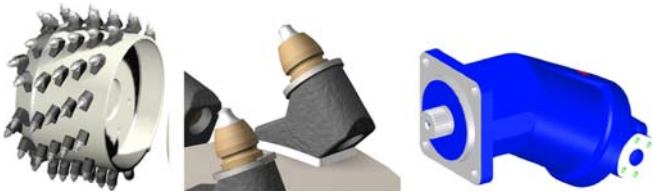

Figure 4 The main elements of milling heads systems

2.3 Cutting wheels

Cutting wheels are the milling tool systems designed in such a way to enable the procession of profiles with relatively small widths in relation to the depth. They are attachments for excavators, backhoe loaders, loaders, skid steer loaders and telescopic handlers, as shown in Figure 5. [5]

Figure 5 Cutting wheel system

The main elements of this system are cutting wheels, picks, bearings, structure and drive, as shown in Figure 6.

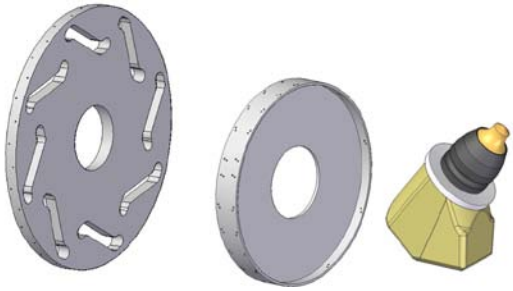

Figure 6 Cutting wheels (left) and pick (right)

3 Modelling of a milling tool system

Modelling of a milling tool system was performed at the component and assembly levels. Modelling at the component level was carried out in the CAD module of the Solid Edge software package. Modelling of a milling tool system at the assembly level is very important because establishment of assembly relations meets kinematic requirements which enable a proper process of cutting, procession of surfaces. Solid Edge possesses a module for modelling products at the assembly level, the so-called assembly module, i.e. CAA environment. The

assembly structure is established on the basis of assembly relations defined, in this software package, through fitting of surfaces, alignment of elements, parallelism, perpendicularity, etc. [3]

3.1 Modelling at the component level

The main activity in physical realization of products is creation of models of virtual prototypes as well as variant design of families of products. Geometrical information about the product includes types of surfaces and edges, their dimensions and tolerances.
Nowadays, in the era of creation and exchange of information in their electronic form, the emphasis is placed on communications in production, without any paper documentation. This is the way to create conditions for using digital geometrical information from CAD during creation of the assembly structure in the CAA environment, as well as in design of technology of creating a part in CAM, by using the rules of integration and translation for the purpose of efficient realization of production of a part.
On the basis of geometrical models of components of milling tool systems that are presented in Figure 7, parameters for a lot of other applications, such as calculations of moments of inertia, volume and mass of products, analyses of mechanisms, FEM modelling and NC programming, are generated.

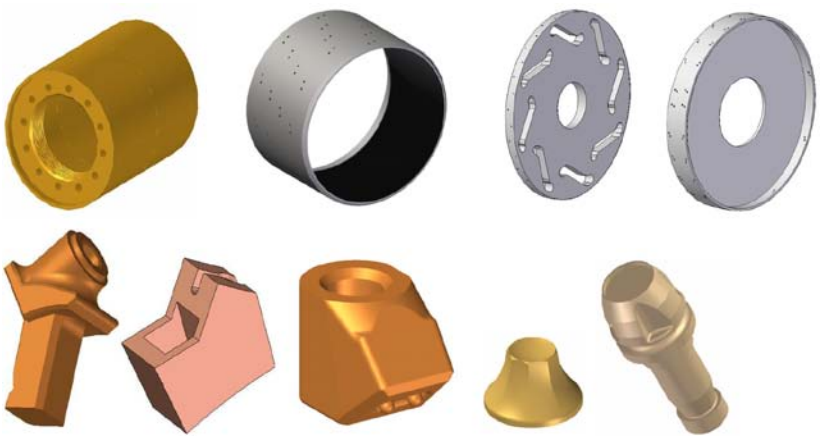

Figure 7 CAD models of components of milling tool systems

3.2 Modelling at the assembly level

In comparison to modelling at the component level, the problem becomes considerably complex in research on approaches and ways of modelling the assembly structure, that is the executive bodies of functions and processes.
Assembly primitives are defined during modelling for assembly; they are represented by relations between functional and effective surfaces defined at the component level taking into account the hierarchical structuring of the product.
The analysis of forming primitives starts from the function of the mentioned assembly. On the basis of functional requirements, it is necessary to recognize the holders of functions, i.e. the executive bodies for the level at which a primitive is defined, and then the skeletons of the subassembly, i.e assembly is formed. The appearance of cutting subassemblies modelled in the CAA environment is shown in Figure 8. [4]

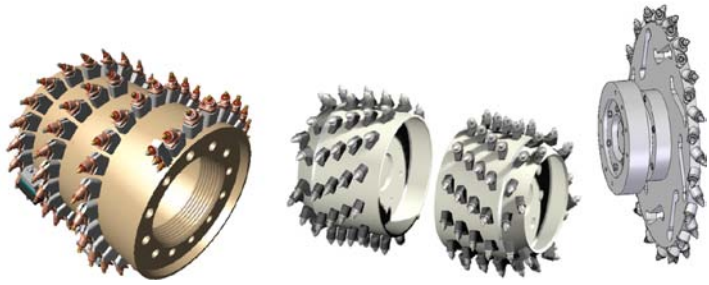

Figure 8 Cutting subassemblies in milling tool systems

Variant and parameter design of these systems were carried out according to the clients' requirements. Variant design is connected with the number of picks, whereas in parameter design the diameter and width of the tool carrier change (drum, head, wheel), as presented in Figure 9.

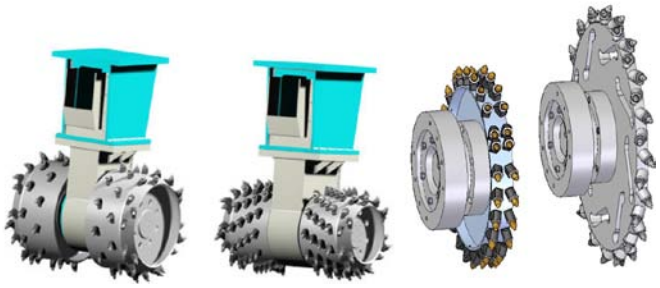

Figure 9 Variant and parameter designed milling tool systems

4 Conclusion

Milling tool systems for procession of road and railway infrastructure facilities are very complex. The complexity is seen in the number of components as well as in providing appropriate spatial arrangement among them. It primarily refers to the subassembly of the pick (cutting elements) in order to have kinematic requirements of cutting fulfilled and appropriate motions provided. Therefore, design of these systems in the virtual CAD/CAA environment and CAM design of technology are very important, which reduces the possibility of errors and shortens the design time with the reduction of costs.

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