DESIGN PROPOSAL OF DIMENSIONS OF SLOTS BY DIGITALIZATION OF STANDARDIZED DIMENSIONS OF KEY

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The paper describes created applications for matching the dimensions of tight keys to shafts and design proposal of a slot for tight keys in the shaft and in the hub. The designed application determines basic dimensions in dependence on shaft diameter: breadth, height of the key and specifies the depth of the slot in the shaft and in the hub with corresponding marginal deviations of dimensions. The application is created in the NetBeans program by the Java programming language. The application can be used by technically oriented students as well as workers in the technical field.

KEYWORDS

Applications, tight keys, hub

1 INTRODUCTION

The submitted paper deals with the creation of application for a design proposal and for matching the dimensions of tight key to the shaft and design proposal of the slot for the tight key in the shaft and in the hub. The tight key is a connection component fitting into the slot of the shaft and in the hub with torque being transmitted only by the sides of keys. The key slots are made with tolerances prescribed by standards.

The objective of the paper is to present a simple designed application created by means of non-complicated program, i.e. by the NetBeans program and by the Java programming language. The designed application shall generate calculation of breadth, height, and length for tight key, upper and lower deviation for the shaft, the hub, the breadth and the roundness.

2 CONNECTING KEYS

As standard the key fits into the slot and in the middle of its upper area and slot bottom in the hub there is a gap therefore torque or peripheral force on the shaft periphery is transmitted along the side area of the key. This category of keys is without bevel.

The keys are used in the cases in which the connected components are locked against axial shift in a different way or if they are to move along the shaft.

The key fits into the slot of the shaft and in the hub. In case of such connection the sides of keys transmit the entire torque. Eccentric position of the shaft hub is not produced by radial force. The connecting keys are therefore used with connections in which higher demands are laid upon alignment of connecting parts.

The standards refer to exchangeable (free) and to fitting (tight) keys. Drawn wedge steel is used to produce keys and wedges.

The slots created for keys are processed with tolerances prescribed by standards. Useful mating is not needed and therefore they are referred to as exchangeable. At the same time, they can be used to mate the parts shifted along the shaft. In the slot the exchangeable keys must be tightened by one or two screws with a sunk binding head. There are keys which are long with thread hole designed for pulling the key out of the slot by a pushed screw. The long keys also have thread hole designed for pulling the keys out of the slot by a push-out screw. The keys with side areas being mated into the slot in the shaft are located in the hub by means of backlash with the determined adjustable location. An appropriate clearance between upper area of key and slot cannot be omitted. On occasions two keys can come into contact face to face which alleviates nominal pressure acting upon key sides.

In fitting (tight) keys side as well as supporting areas are mated. They are employed in transmission of large forces, in case of rotation of rotating components, etc. The rotating masses are used to balance two opposite keys. In such case the wedges cannot be used as in the consequence of wedge driving the components would be located eccentrically and thus unilateral centrifugal force would be produced which could result in high stress of the shaft. Dimensions of slots, keys and permitted deviations are in accordance with standards.

To allow shifting of the component along the shaft the guiding keys are used which are locked in the slot of the shaft by sung screws with the binding head. Therefore, the side areas of key are mated with the hub. The keys are utilized in all cases in which the wedge driving would result in imbalance of rotating masses. Any detailed dimensions related to key location are given by STN standards.

Quite often the keys are replaced by slot shafts. Therefore, the shaft has several keys milled on it for which necessary slots are formed in the wheel hub. Number of slots depends on shaft diameter, method of loading, transmitted torque as well as on the fact whether the component is fixed or movable.

Standardized connecting keys being square lengthwise and Woodruff keys are used to connect shafts with components. The wedges are not recommended to be used in case of compressors, centrifugal pumps and toothed wheels and especially in case of components located in rolling contact bearing – tight keys [Pavlenko 2017a,b].

2.1. Tight Keys

Tight keys are the most widely used. Only length is proposed and checked. Breadth and height are both automatically matched to the shaft diameter. (Fig.1) Breadth of slot in the shaft and in the hub has marginal deviation P9. The dimensions are given in the tables. (Tab.1) (Tab.2) [Pavlenko 2017].

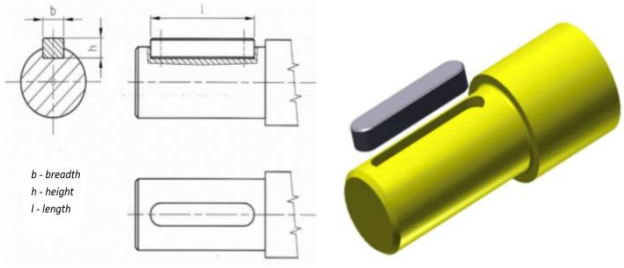

Figure 1. Tight keys

2.2. Woodruff Keys

Woodruff keys are shafts of low diameters for transmission of small torques. The key has a shape of part of a disk. The disadvantage of Woodruff keys rests in weakening of cross section of shaft by depth slot. Currently, they are rarely used (Fig. 2).

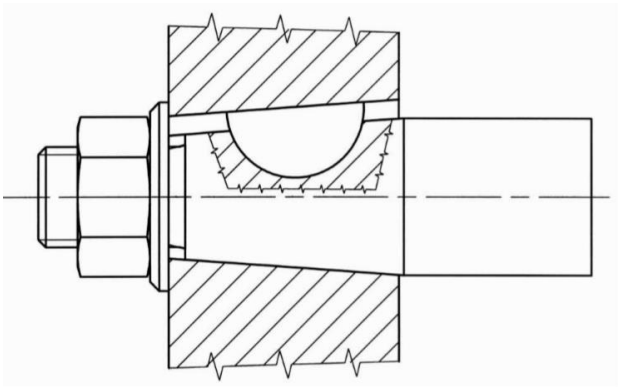

Figure 2. Woodruff keys

2.3. *Exchangeable Keys*

Only key length is proposed and checked. (Fig. 3) It allows axial shift of the hub. The exchangeable keys are connected to the shaft by screw. They are standardized.

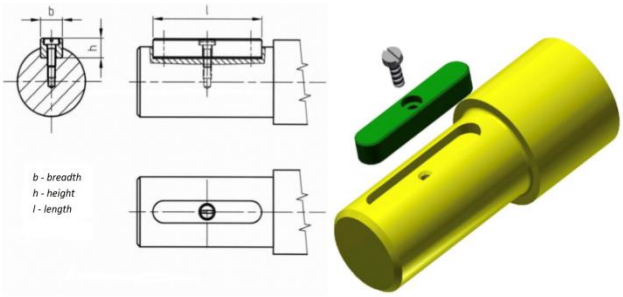

Figure 3. Exchangeable Keys

2.4. *Key Joint*

Advantage of key joint contrary to the wedge one is that occurrence of "decentred location" is absent and the installed disks do not flap. The key joint is always opt for in cases in which precise alignment of components is required. They transmit torque with possibility of axial shift of the installed component such as shifting clutch, toothed wheels, etc. [Murcinkova 2013]. Side areas of the key are mated in the shaft slot in which clearance for adjustable location can be observed.

2.5. *Stress of Tight Key*

Tight key is subjected to shear and pressure stress.

Calculation of key shear stress

$$\tau_s = \frac{F}{S} \leq \tau_{DS} \ (1.1) \quad => \quad \tau_s = \frac{F}{b.l} \leq \tau_{DS} \tag{1}$$

Calculation of key pressure stress

$$p = \frac{F}{S_P} \leq p_D(1.3) \quad => \quad p = \frac{F}{t_1.l} \leq p_D \tag{2}$$

2.6. *Proposal of Key Slot Dimensions*

STN 022507 standard prescribes matching of dimensions of tight keys to shafts, their dimensions as well as key slot tolerances. On the basis of shaft diameter, the standard determines dimensions such as breadth b and height h of the key and defines depth of the key located in the shaft and in the hub with respective marginal deviations of dimensions. Extracts from the aforementioned standard are given in tables (Tab. 1) (Tab. 2).

Table 1. Matching of tight keys to shafts; dimensions are given in mm (STN 022507 standard)

Shaft diameter		Key		Slot							
		Breadth b	Height h	Depth				Breadth		Roundness	
				In the shaft		In the hub		b	P9*	R	Marginal deviations
				t	Marginal deviations	t 1	Marginal deviations				
6	8	2	2	1,1	+0,1	0,9	+0,2	2	-0,009	0,2	0
8	10	3	3	1,7	0	1,3	+0,1	3	-0,034		-0,1
10	12	4	4	2,4		1,6		4	-0,012	0,4	0
12	17	5	5	2,9		2,1		5	-0,042		-0,2
17	22	6	6	3,5	+0,2	2,5		6			
22	30	8	7	4,1	0	2,9		8	-0,015		
30	38	10	8	4,7		3,3	+0,4	10	-0,051	0,6	
38	44	12	8	4,9		3,1	+0,2	12	-0,018		
44	50	14	9	5,5		3,5		14	-0,061		
50	58	16	10	6,2		3,8		16			
58	65	18	11	6,8		4,2		18			
65	75	20	12	7,4		4,6		20	-0,022		
75	84	22	14	8,5		5,5		22	-0,074		
85	95	25	14	8,7		5,3		25			
95	110	28	16	9,9		6,1		28		1,0	0 -0,3

Table 2. Dimensions of standardized tight keys according to STN 022562 standard

b	h	R	Length range l	b	h	R	Length range l
2	2	+0,1	8 až 20	18	11	+0,2	50 až 200
3	3	0,25 0	8 až 36	20	12	0,7 0	56 až 220
4	4	+0,2	10 až 45	22	14		63 až 250
5	5	0,5 0	12 až 56	25	14	+0,3	70 až 280
6	6		16 až 70	28	16	1,2 0	80 až 315
8	7		20 až 90	32	18		90 až 355
10	8	+0,2	25 až 110	36	20		100 až 400
12	8	0,7 0	32 až 110	40	22		110 až 440
14	9		40 až 140	45	22	+0,5	125 až 440
16	10		50 až 180	50	28	2,0 0	140 až 440

3 CREATED APPLICATION FOR PROPOSAL OF SLOT DIMENSIONS BY DIGITALIZATION OF STANDARDIZED DIMENSIONS

The designed application was created by means of a simple program, i.e. by the NetBeans program and by the Java programming language. The designed application shall generate calculation of breadth, height, and length for tight pen, upper and lower marginal deviation for shaft, hub, breadth and roundness.

3.1. *Java*

3.1.1. *Java as a Platform*

The term of Java has become a synonym for three basic areas.

- programming language of Java – programming language with its structure and syntax.
- Java Core API – standard libraries which must appear in all Java distributions.
- JVM – positive feature of the approach rests in the fact that the program once translated in Java can be applied anywhere provided that JVM shall be available. Java itself is a platform, i.e. it does not depend on any other platform. To be more precise, the platform is represented by the operating environment of Java (Java Runtime Environment) which consists of interface of application programming and of other components. It is helpful in releasing and matching of the memory sources and secures work with hardware.

3.1.2. Java as the Interpreted Language

Java is an interpreted language. It means that compressing of the source program is not performed directly from the machine language yet from the intercode which is interpreted and compressed by a virtual machine into machine language of the hosting OS. The program activation can be divided into the following steps:

1. Editing
2. Compilation
3. Load
4. Verification
5. Execution

3.1.3. Method of Program Processing in Java

Standard procedure in the Java program runs through five stages, i.e. editing, translation (compilation), load, verification and execution. Four out of these stages are also common in other programming languages. The verification stage is the new and rather important one as it allows achieving of very safe program activation by means of which protection of the person activating the program is assured [Šmeringaiova 2018 a,b].

The Java language is independent from the target computer which in practice means that a programmer does not need to be interested in fact what computer shall its program appear in. It is enabled by the program bytecode program stored in the file with the reserved suffix .class. From the disc the file is sent to the computer memory and at the same time bytecode verification is performed which can be carried out owing to bytecode independence from the platform. Once the verification has been completed the program shall be activated by means of the interpreter as Java is the interpreted language alike Basic.

3.2. NetBeans

NetBeans IDE is official IDE for Java. It is the best support for the latest Java technologies. Through its editors of analysers and converters of codes it can promptly and smoothly upgrade its application by using new Java. Batch analysers and converters allow browsing through several applications at once which facilitates user´s work. Java constantly improves editors by a number functions and by broad scale of tools, templates, and samples. NetBeans IDE sets a standard for development of state-of-the-art technologies immediately when the program is activated. IDE represents far more than a text editor. BetBeans Editor contains links, word bases and brackets and it systematically and schematically improves to source code. It allows simple implementation of code with many useful tools with high performance and at the same time it provides code templates, coding hints and code generators. The editor supports many languages from Java, C / C++, XML and HTML, PHP, Javadoc, JavaScript and JSP. With regards to the fact that the editor can be spread, it can get involved in support with a number of other languages [Krenicky 2011, Maščenik 2017a,b].

3.3. Created Application

Figure 4 shows final graphic design proposal of the application in case of which the program user enters shaft diameter and consequently, the application determines dimensions such as breadth b, key height h and prescribes slot depth in the shaft and in the hub with the corresponding marginal deviations of dimensions. Furthermore, the application contains buttons in the shape of the " i " letter which serve for display of the guiding figure. If the user enters a value which has not been standardized according to the table the user shall be warned by the application about having entered the value out of the range [Bičejová 2017 a,b].

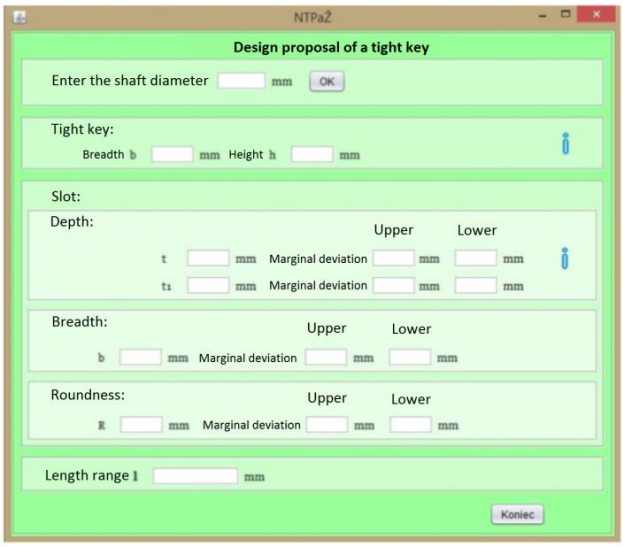

Figure 4: Created application

4 CONCLUSION

The paper describes created application which allows matching the parameters of tight keys to shafts and design proposal of slot for tight keys in the shaft and in the hub. Function of the application is to facilitate search for given parameters to students of technically oriented schools as well as to workers of the technical field. The main priority of the created application is generation of values provided that the user enters correct shaft diameter. The table shall automatically display the values determining breadth and height of tight key, depth of slot in the shaft and in the hub, breadth of roundness and length range for tight keys. The application contains figures which facilitate the work and allow the user faster orientation. The application can be simply downloaded from the web page the part of which is also the Java SE module inevitable for activation of the application. The application is well-arranged, simple as to operation and allows acceleration of calculation of desired dimensions. Correctness of application function was verified in case of several application examples.

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