Java for Mechanical Design Computation:
Dimensions of the Various Flange Couplings

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Abstract: Coupling is most commonly used machine element it is required to do computation of dimensions for each and every application separately and it consumes time for every set of calculation. Java is most emerging programming language in scientific computing. Since java is Object oriented and high level programming language leads to use that for computation. The current work deals with the dimensional computing of various types of flange coupling by considering the various stresses in all elements. In current work we considered standard materials for the elements and also provision given to change the material and stresses in the machine members. With help of java we can compute the couplings in shorter duration with precise values.

Keywords: Flange coupling, dimensional computing, object oriented programming

1. INTRODUCTION
Java is an object-oriented programming language which can be used to generate the applications and applets such as user interfaces. Java also has vast standard libraries for various applications such as doing mathematics. Even though the FORTRAN has numerous features that make it particularly useful for scientific calculations/Programs and also FORTRAN compilers tend to produce highly efficient code compared to the compilers for other languages. We think that it is time to replace the FORTRAN with a modern language that also provides these features.

Much of the syntax of Java is the same as C and C++. One major difference is that Java does not have pointers. However, the biggest difference is that you must write object oriented code in Java. Procedural pieces of code can only be embedded in objects. In the following we assume that the reader has some familiarity with a programming language. In particular, some familiarity with the syntax of C/C++ is useful.

Java is related to both C and C++. In fact its syntax is most similar to both the languages. Each innovation in Programming language design was driven by the need to solve a fundamental problem that the preceding languages could not solve.

Although Java has attractive features for producing portable, architecturally neutral code, it is not widely used in engineering computations. Java has too much to present to be overlooked. First of all, Java is portable at both the source and object format levels. The java program file i.e. source file to be saved as a .java file. The object format is the byte code in a .class file. Either type of file is expected to behave the same on any computer with the appropriate Java compiler and Java virtual machine. Second, Java code is safe to the host computer. Our initial focus will be on writing applications. When a program is compiled, a byte code generates that can be read and executed by any platform that can run Java.

1.1 Flange Coupling:
A flange coupling typically used to join the two shafts of same diameter aligned in same axis. Flange couplings do not allows axis deviation between two shafts. It consists of two flanges generally made up of cast iron. Each flange is mounted on the shaft end and keyed to it. Two flanges are holds together in position with help of bolts. The number of bolts may depend on the perimeter of the pitch circle in turn the diameter of the shat used to connect.

Flange couplings generally classified into three types
1. Protected Flange Coupling
2. Unprotected Flange Coupling
3. Marine Flange Coupling

The difference between these coupling is in protected flange coupling an extra hallo shaft type layer is casted to protect the bolts, such layer is not provided in unprotected type and in marine type couplings tapered bolts are used instead of regular headed bolts.

In current work involves in computing the dimensions of all three types of flange couplings, while computing the coupling and shaft materials are considered as cast iron and mild steel. If the material of the coupling for which computing is made up of differ material from the default one can also compute by giving the ultimate stress values.

1.2 Notations used

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tov</td>
<td>Ultimate shear stress of material</td>
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<tr>
<td>sigmac</td>
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</tr>
<tr>
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<td>Shaft</td>
</tr>
<tr>
<td>k</td>
<td>Key</td>
</tr>
<tr>
<td>sl</td>
<td>Sleeve</td>
</tr>
<tr>
<td>f</td>
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</tr>
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Next lines contains the conformation of the materials used in computation, for this purpose ‘if-else’ condition is used. Material consideration is very important to consider the safe stresses of components. In default the following materials are considered for designing.

Flange – Cast Iron
Key, Bolt, Shaft – Mild steel.
If the material of the components are not matched with the user one, then option is provided to change the material user need to enter the safe stresses of the material with which he is dealing. Once material is conferred then next lines are for creating an object that contains its own copy of each instance variable defined by the class. 

\textit{flangecoupling fc=new flangecoupling();}

Calling the methods of different flange couplings by giving input values given by the user.

\textit{fc.upfc(d,N,tovs,sigmacs, tovk, tovsl, tovf, tovb, sigmacb);} \textit{fc.protect(d, N, tovs, sigmacs, tovk, tovsl, tovf, tovb, sigmacb);} \textit{fc.marine(d, N, tovs, sigmacs, tovk, tovsl, tovf, tovb, sigmacb);}

\textit{fc.upfc} is the method for computing the dimensions of unprotected flange coupling.

Coding of few parameters of unprotected flange coupling will be as follows.

<table>
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<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Java code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer diameter</td>
<td>( D=2d )</td>
<td>double ( D=2*d; )</td>
</tr>
<tr>
<td>Pitch circle diameter</td>
<td>( D_1=3d )</td>
<td>double ( D1=3*d; )</td>
</tr>
<tr>
<td>outer diameter of</td>
<td>( D_2=4d )</td>
<td>double ( D2=4*d; )</td>
</tr>
<tr>
<td>the flange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of the</td>
<td>( L=1.5d )</td>
<td>double ( L=1.5*d; )</td>
</tr>
<tr>
<td>sleeve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque transmitted</td>
<td>( T=\frac{\pi d^2}{16} )</td>
<td>double ( T=(\pi/16)<em>(d</em>d)*tovs; )</td>
</tr>
<tr>
<td>y flange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>core diameter of</td>
<td>( Dc=\frac{ts}{24} )</td>
<td>double ( Dc=Math.sqrt((8<em>Ts)/(\pi</em>tovb<em>nb</em>D1)); )</td>
</tr>
<tr>
<td>the bolt</td>
<td></td>
<td></td>
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3. RESULTS & DISCUSSIONS
While running the program, first the program will be converted to machine code that we generally called it as generation of class file. In first step we need to execute the java file for that following syntax has to follow 
\textit{Dive/ folder (if any) > javac filename with extension.java}\nIf there is no error .class file will be created. To execute class file which is in machine language the following syntax will be used.
\textit{Dive/ folder (if any) > java class name}\nThe Program file is named as flangecoupling.java, class is named as flange coupling and it is executed as follows.
The first message displayed as ‘Enter the diameter of the shaft (in mm):’ here user need to enter the shafts diameter for which coupling is designing. Next message will be as ‘Enter the speed of the shaft (in rpm):’ here user need to enter the at which speed shafts coupled to coupling are rotates.

Next message is for material conformation, here the default materials will be displayed then user need to confirm the materials with which he is going to design is same as displayed or not, if it is not then he need to enter the material of the each component like shaft, flange, key and bolt. If it is yes then the results will be displayed on the screen in the fraction of seconds.

Let us consider a case in which the flange material differ than the default one,

Flange: Material-1 (assuming flange and hub are made up of same material)
Shaft: Material-2, key: Material-3 and Bolt: Material-4

After entering the all the required values by pressing the enter key we will get the output as design details of various flange coupling as shown below

H:/Java Flangecoupling.java
Note: flangecoupling.java uses or overrides a deprecated API.
Note: Recompile with -Xlint:deprecation for details.
H:/java flangecoupling

enter the diameter of the shaft(in mm):30
enter the speed of the shaft(in rpm):3000
following materials are considered for computation:
Flange: Cast Iron
Shaft, Key, Bolts: Steel
enter 1 if yes 0 to change
0
enter the flange material
Material-1
enter the allowable shear stress of Material-1(in Mpa)
16
whether flange and sleeve are of same material
enter ‘1’ if yes, ‘0’ of no
1
enter the shaft material:
material-2
enter the allowable shear stress of material-2(in Mpa)
42
enter the allowable crushing stress of material-2(in Mpa)
84
enter the key material:
material-3
enter the allowable shear stress of material-3(in Mpa)
56
enter the bolt material:
Material-4
enter the allowable shear stress of Material-4(in Mpa)
112
enter the allowable crushing stress of Material-4(in Mpa)

Design details of unprotected flange coupling

Cross sectional area of shaft : 706.8825 sq.mm
outer diameter of sleeve : 120.0 mm
hub diameter of sleeve : 60.0 mm
pitch circle diameter of sleeve : 90.0 mm
length of the hub : 45.0 mm
thickness of the flange : 2.4609375 mm
length of the key required : 58.0 mm
no. of keys required::2
safe width of the key : 4.570360991379311 mm
safe thickness of the key : 6.093814655172414 mm
minimum diameter of the bolt required:
7.290148043997554 mm
number of bolts required : 3
minimum length of the bolt : 10.753993435198044 mm
Torque transmitted by shaft : 222667.98750000002 N mm
Torque transmitted by coupling : 222.6679875 N mm
power transmitted by shaft : 69958.60163287501 kw
power transmitted by coupling : 90420.61745820717 kw

Design details of protected flange coupling

Cross sectional area of shaft : 706.8825 sq.mm
outer diameter of sleeve : 120.0 mm
outer most diameter of the bolt : 135.0 mm
hub diameter of sleeve : 60.0 mm
pitch circle diameter of sleeve : 90.0 mm
length of the hub : 45.0 mm
thickness of the flange : 2.4609375 mm
thickness of protection groove : 7.5 mm
length of the key required : 58.0 mm
no. of keys required::2
safe width of the key : 4.570360991379311 mm
safe thickness of the key : 6.093814655172414 mm
minimum diameter of the bolt required:
7.290148043997554 mm
number of bolts required : 3
minimum length of the bolt : 10.50217108799511 mm
Torque transmitted by shaft : 222667.98750000002 N mm
Torque transmitted by coupling : 222.6679875 N mm
power transmitted by shaft : 69958.60163287501 kw
power transmitted by coupling : 90420.61745820717 kw

Design details of marine flange coupling
Cross sectional area of shaft : 706.8825 sq.mm
outer diameter of sleeve : 66.0 mm
hub diameter of sleeve : 48.0 mm
length of the hub : 45.0 mm
thickness of the flange : 10.0 mm
length of the key required : 58.0 mm
no. of keys required::2
safe width of the key : 4.570360991379311 mm
safe thickness of the key : 6.093814655172414mm
minimum diameter 0f the bolt required : 8.645052112070127 mm
number of bolts required : 4.0
minimum length of the bolt : 26.9160416896561 mm
Torque transmitted by shaft : 222667.98750000002 N mm
Torque transmitted by coupling : 579.0781440000001 N mm
power transmitted by shaft : 69955.60163287501 kw
power transmitted by coupling : 232379.000772445 kw

THANKYOU

4. CONCLUSION:
In this paper we have summarized our work on dimensional computation of various flange couplings precisely in shorter duration by using java. We have developed a tool for auto computing of dimensions of flange coupling with design and stress considerations. With this program any one can compute the dimensions of the coupling with in fraction of seconds. The provision given to change the flange, shaft, key and bolt material will be added advantage for the tool. Since the simplicity in operation and possibility of changing the material this tool can be used in all design and fabrication industries.

References