Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 3, Issue 7; April-June, 2016, pp. 575-579

http://www.krishisanskriti.org/Publication.html

Customization & Analysis of Brake Drum

Sagar N. Tale[1] and B M Dabade[2]

[1]PG Scholar SGGS IE&T Nanded
[2]BOM & Professor SGGS IE & T Nanded
E-mail: [1]sagartale1991@gmail.com, [2]bmdabade@sggs.ac.in

Abstract—*One of the most powerful features of CAD systems is customization. With customization is possible to create new commands and ways of human-machine interaction that ease repetitive or complex tasks. In this paper, we discuss the main issues involved in creating customized systems for the final user and the requirements for the programmer and systems analyst. Based on the models of Software Engineering in this project we are developing custom tool for brake drum in UG-NX8.5 by using OPEN API. This project consists of various types of brake drum design & drafting. This design of brake drum uses OPEN API used in UG-NX Software. In this system of generation of part module a third party software which is known as IDE for development of software called VISUAL-STUDIO is used. This software links the code of brake drum design which is present in C++/VB to UG-NX software where we can run the code & obtain design for brake drum In this project we are designing various types as indicated by the user interface created for the development of the various categories of brake drum and it's drafting diagrams in a single used for interface. As we know that brake is a device which converts power of momentum or kinetic energy of a moving vehicle into heat by means of friction. Due to friction of drum with brake shoe heat goes on increases and results in fading of brake drum which results to failure. This has been tested by experimentally by various researchers in china and I am simulating this results with the help of analysis software by performing transient thermal analysis and comparing results with experimental results due to this fading there various effects on drum brake like increase in baking force, increase in stopping distance and temp increase due to that increase in coefficient of friction of lubrication fluid so to overcome this various methods are applied by researchers one of them is increase in the rate of convection and conduction so that we can increase rate of cooling by implementing the fins on the surface of brake drum and showing the results of analysis which shows less generation of temperature and also I am checking the effect of actuation pressure on drum brake By means of stress analysis and modal i.e. vibration analysis.*

1. INTRODUCTION

In the last few decades we have seen the emergence of many Computer Aided Design programs. Some of them claim to be designed to address the needs of specific disciplines like AEC, Mechanical Engineering, Electronics and others. While offering the more general tools, there is no way to know what each individual user may find useful to accomplish very specific tasks. One can suppose that those limitations have stroke the minds of the developers of the CAD systems very early so they build the capability of customization into their programs. With customization, it is possible to modify or create new tools that are better suited to our needs. One of the great improvements we can get with customization is to replace a series of otherwise boring, to say the least, commands with a single tool that does the job. The major CAD systems have a wide range of customization interfaces that go from as simple as Assigning commands to function keys to complete development environments including high level programming languages and resource compilers.

1.1 Software Engineering Technique for Customization

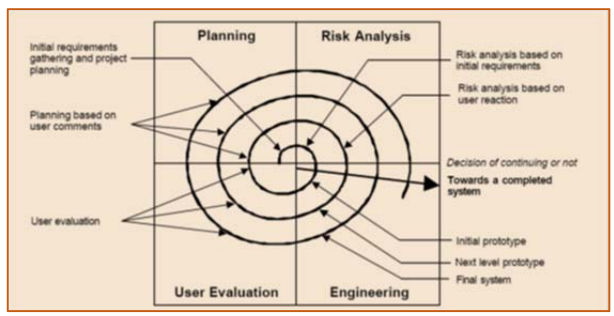

Fig. 1: Software Engineering Model

Considering the procedure just outlined, it should be clear that — given the similarities with Standard software development — Software Engineering can and has to be applied to customization.

The spiral model of Software Engineering is the one that best describes the life cycle of a Customized application. This model includes the classic approach with prototyping and introduces a new element — risk analysis. The main tasks presented by the spiral model are

· Planning: objectives, alternatives and restrictions determination.

· Risk analysis: analysis of alternatives and identification/resolution of risks.

· Engineering: development of the "next level" product.

· User evaluation: evaluation of the engineering results.

During the first cycle around the spiral, objectives, alternatives and restrictions are defined and

Risks are identified and analyzed. If risk analysis indicates uncertainty in the requirements, prototyping can be used in the engineering quadrant to help the analyst and the user. Simulations and other models can also be used to refine the requirements.

Initial requirements gathering is not always easy because many users do not have a clear idea of their needs. With customized systems the analyst can expect the user to have a better understanding of the overall procedure since he already uses the standard tools and can point the repetitive, inefficient and complex task of his everyday work. On an initial approach, the analyst should try to prototype will supply elements for risk analysis and give the user a taste of what he can expect. We state that prototyping applied to customization is the most effective paradigm to get a Working system in a short period of time (typically one or two weeks). Indeed, with customized Systems the initial prototype is used as the first version of the system and its continued improvement along the spiral cycle leads to the final system.

2. BRAKE DRUM

Among the various types of devices to be studied, based on their practical use, the discussion will be limited to "Drum brakes" of the following types which are mainly used in automotive vehicles and cranes and elevators.

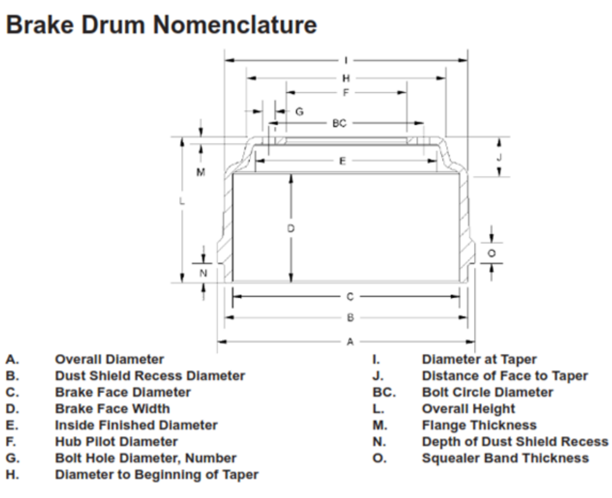

Fig. 2: Brake Drum Nomenclature

Drum brakes, like most other brakes, convert kinetic energy into heat by the frictional contact between parts. When the brake is applied, the lining pushes against the inner surface of the drum, generating friction heat that can surrounding air, but can just as easily transfer to other braking system components. Reach as high as 500°C. This heat should dissipate into the Brake drums must be large enough to cope with the massive forces exerting by adjacent components, and must be able to absorb and dissipate a lot of heat. However, excessive heating can occur due to heavy or repeated braking, which can cause the drum to distort, leading to vibration under braking. The other consequence of overheating is brake fade this is due to one of several processes or more usually an accumulation of all of them. When the drums are heated by hard braking, the diameter of the drum increases slightly due to thermal expansion, so the brake shoes must move farther and the driver must press the brake pedal farther.

2.1. NX OPEN API

Open API (User Function) is a collection of routines that allows programs to access and affect the NX Object Model. In addition to the routines, there are tools provided to compile and link programs in a manner consistent with what NX expects.

Open API programs can run in two different environments, depending on how the program was linked. The two environments are:

External: These programs are standalone programs that can run from the operating system, outside of NX, or as a child process spawned from NX. Although external programs do not have a graphics display, the API provides functions that allow plotting and the creation of CGM files.

Internal: These programs can only be run from inside of an NX session. These programs are loaded into the NX process space. One advantage to this is that the executable are much smaller and link much faster. Once an Internal program is loaded into memory, it stays resident for the remainder of the NX session unless you utilize the facilities within the API to unload it. The results of internal API programs are visible in the graphics window of an NX session.

Open API is a product name that encompasses the flexible integration of many different software applications with NX through an open architecture. The intent is for the integrated applications, along with third party and NX applications, to share data on different computer platforms, from different locations (heterogeneous network), and even access its content over the Internet. Open API, by design, focuses on enabling open architectures to be utilized by third parties, customers, and in-house users when integrating or customizing software applications.

The Open API provides the applications and tools that enable customers to:

- Interface with the NX Object Model through Open C and C++ API or GRIP.
- Create and manipulate User Defined Objects (also referred to as Custom Objects) including managing their associativity with other NX objects and providing methods for updating and displaying the User Defined Objects.

- Customize the NX graphics interface to reflect third party applications.
- Take advantage of related products such as, Team center engineering process management ITK, and Parasolid.
- Utilize and integrate new Open API technologies as they become available.

The key idea is to provide many applications (applications can consist of third party, integrated, and NX applications) that enable customers in geographically diverse locations to work simultaneously on information which they can share throughout their enterprise. The reason for providing such applications is that in order to support global manufacturers' Fast-to-Market and/or Global Integration strategies they need solutions that allow geographically diverse locations and multi-disciplinary teams to collaborate more effectively on designing, developing, and manufacturing mechanical products. For example: collaboration between geographically different product development sites, between different companies allied to jointly develop products, between designers and engineers/analysts, between designers and machinists, between product development and manufacturing sites, between manufacturers and their suppliers, etc.

2.2. USER INTERFACE FOR BRAKE DRUM

This user interface is for brake drum design from Nomenclature of brake drum. And it is used for the development for the design of various types of brake drum.

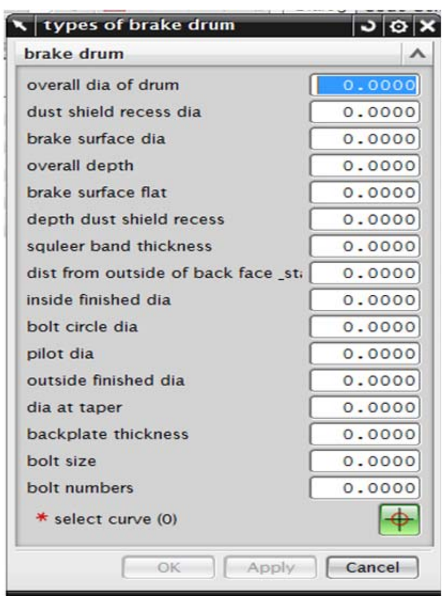

Fig. 3: UI for Brake Drum

3. ANALYSIS OF BRAKE DRUM

Three-dimensional finite element model of a drum Brake is built in this paper and other relevant national standards, using ANSYS Workbench, brake drum thermal field is simulated and studied. Through several simulation methods revised about initial conditions, to achieve fitting of the simulation curve and test curve. The boundary conditions for temperature field analysis and simulation methods of the brake drum are confirmed, and the effects of the process of braking speed, braking frequency and braking force etc. to brake drum thermal field are studied. To provide an important reference for the thermal performance analysis of brake at design stage.

3.1. HEAT TRANSFER MODEL OF DRUM BRAKE THERMAL FIELD AND TEST RESULTS

3.1.1. Simplifying physical model of drum brake

Theoretical research shows that, for organic friction material lining, about 95% of the heat that generated in braking process is absorbed by brake drums and brake disc, and the remaining 5% of the heat is absorbed by the friction plate or brake pads, thus the physical model of drum brake is simplified as follows:

The function of brake bottom plate is used to fix brake shoe and to block foreign bodies inside drum brake, although the side gap of the brake drum is small, there is no direct contact, assuming that no heat transfer between them.

Ignoring the influence that the other parts of the brake apply to heat generation and heat transfer process.

3.1.2. Drum brake heat fade test

The test is carried on the fully loaded vehicle. The initial velocity of the vehicle is v1=65krnlh, the terminal velocity of braking in a single cycle is v2=30kmlh, temperature inside brake drum is between 60 °C to 90 °C, the full load weighs 14 tons, wheelbase is 4500mm, acceleration of gravity value is $9.8 m/s^2$, rolling resistance coefficient of ground is 0.018, distribution factor of braking force is 0.47, there is 9 cycles of continuous braking heat fade, a single braking cycle time of T is 60s. The contact thermocouple is used to measure the temperature of inner surface of brake drum in the test. In order to measure the surface temperature inside the brake drum accurately in braking process, the thermocouple sensors should be installed in the position where the largest pressure is between the brake shoe and brake drum, then temperature test can be conducted by temperature sensors, pressure sensors, data processing analyzer and power amplifier.

3.1.3. Determination of heat flux of the friction surface

$q_{1R} = 0.5\,(1-\beta)\,q1$ (1)

Where, Q1R-the friction heat of a single rear brake drum, J; qlR-the heat transfer rate of a single rear brake drum, W; fJ-the braking force distribution factor.

3.1.4. Determination of the convective heat transfer Coefficient of drum brake outer surface

$h_R = 0.92 + \alpha v \times \exp(-v/328)$ (2)

Where, v the velocity of vehicle, ft. /s; α-the coefficient of empirical formula, front brake drum is 0.7, rear brake drum is 0.3.

3.1.5. Determination of Physical Parameters

When emergency braking or braking for a long while, Inner surface of brake drum and brake shoe will have a very high temperature. The parameters of thermo physical properties of the material are changing with temperature, this will lead to changes in physical properties of materials. The higher the temperature is, the more specific heat capacity increases. But the thermal conductivity of the material K does not change much, the material density changes small, so the thermal conductivity and density are specified as Constants. Specific heat capacity is between 500 to600J/kg. DC, the density is 7200kg/m3, thermal conductivity is 52W/m℃ .The effects of radiation considered, radiation coefficient is set as 0.54

3.1.6. Determination of the boundary conditions at each Moment

Using MATLAB to calculate vehicle velocity, heat flux and convection heat transfer coefficient under various conditions corresponding to test at each moment. Braking time is 3.3s, acceleration time is 46.7s, and uniform motion time is 10s. According to the motion parameters of every test conditions, a curve of velocity versus time is plot.

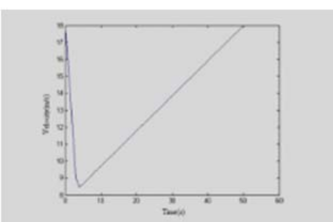

Fig. 4: Velocity vs. time

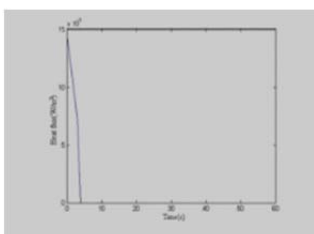

Fig. 5: Heat flux vs. time

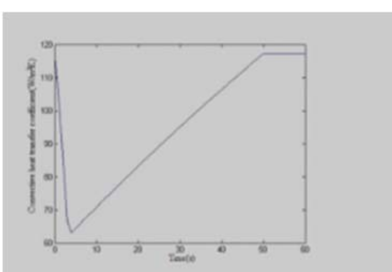

Fig. 6: Convenction coefficient vs. time

4. FINITE ELEMENT MODEL OF BRAKE DRUM

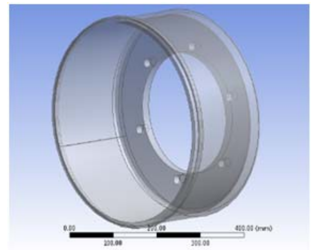

Fig. 7: 3d model of drum

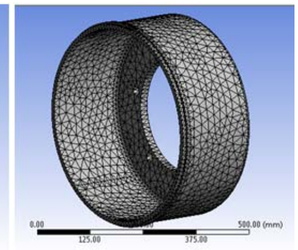

Fig. 8: meshed model of drum

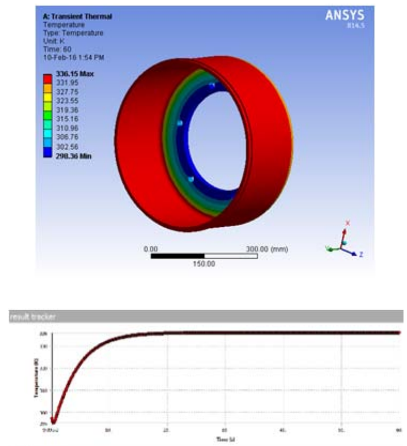

Fig. 9: Temp. Results of analysis

4.1. RESULTS

The brake drum is the large critical part of the braking system that rotates round the brake shoes. When the drum is heated by hard braking, the diameter of the drum increases and the brake pedal must be further depressed to obtain an effective braking action. This is known as brake fade and it has led to driver's panic and brake failure in extreme circumstance. This paper also aimed at tackling this problem. Fins are widely used to enhance the heat transfer from a surface. The use of the fins (extended surfaces) is a thermal management technique used to augment heat transfer by increasing the available surface area and the total heat dissipation. Fins can be found in most electronics, engines, industrial equipment, and a variety of other mechanical devices. The ability of an object to reject excess heat is a required task to ensure operability, and if not accomplished sufficiently, can result in device malfunction or even failure. Therefore, the convective removal of heat from the surface of the brake drum can substantially be improved by introducing extension (fins) on its surface.

5. FINNED BRAKE DRUM DEVELOPMENT

5.1. To Calculate the Fins Spacing s

For the purpose of this paper, the distance between the fins s, is considered to be twice the thickness (t) of the fins,

Thus $s = 2t$ (3)

5.2. To Calculate the Number of Fins N, on the Modified Brake Drum Model

The number of fins (N) round the circumference of the brake drum is given by;

$N = W/t + s$ (4)

Where W = fins Width.

5.3. To Calculate the Outer Radius of the Modified Brake Drum

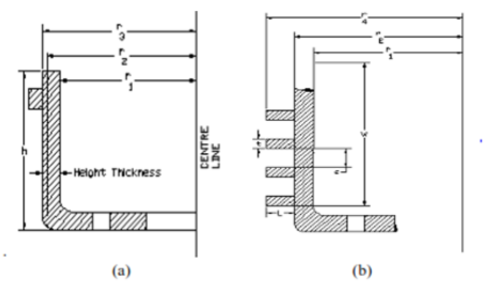

Fig. 10: Modified Brake Radius

Since the overall height thickness of the original brake drum is reduce by one-fourth (1/4) of its original size. Therefore the new outer radius $r2$ is given by;

$$r_2 = r_3 - \frac{(r_3 - r_1)}{4} \qquad r_2 = \frac{3r3 + r1}{4}$$

5.4. To calculate the radius of fins r_4

Since this design involves converting the volume $V1$ into extended surface (fins) of equal volume $V6f$. Therefore the Volume $V1$ deducted from the original model is equal to total volume of the fins $V6t$. Thus

$$r_4^2 - r_2^2 = \frac{\pi\,(r_3^2 - r_2^2)h}{6\,\pi\,t}$$

5.5. To Calculate the Length of the Fins *L*

The length of the fins L, is given by;

$$L = r4 - r2$$

5.6. To Calculate the Total Surface Area of the Fins Afin

$$Afin = 2\pi\,(r_4^2 - r_2^2) + 2\pi r_4\,t$$

5.7. Modified Brake Drum

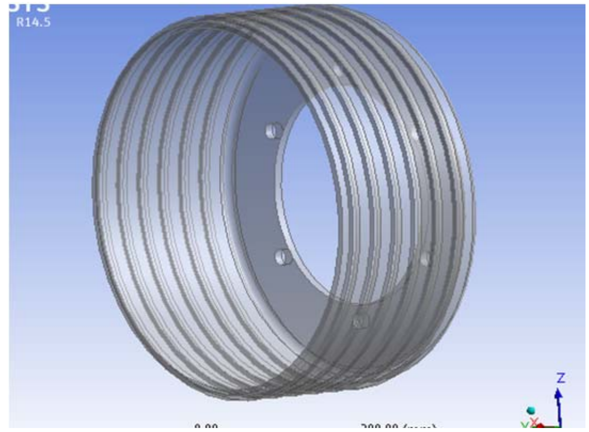

Fig. 81: Modified Brake Drum

REFERENCES

[1] Sérgio Scheer and Wilson H. Bogado COMPUTATIONAL MECHANICS New Trends and Applications

[2] S.Idelsohn, E. Oñate and E. Dvorkin (Eds.)©CIMNE, Barcelona, Spain 1998

[3] Xian Yang, Lifen Wang, Yubin Zhang 2009 International Forum on Computer Science-Technology and Applications.

[4] WANG Ling-yun, HUANG Hong-hui, Rae W. West J. Cent. South Univ. (2012) 19: 3430–3434 DOI: 10.1007/s11771-012-1425-3.

[5] Atul B. Zaware, M. M. MirzaNational Conference for Engineering Post Graduates RIT NConPG - 15. ISBN-13:978-1512094169

[6] Bako Sunday,Usman Aminu, Paul O. Yahaya.Mohammed B. Ndaliman IJIRSET(An ISO 3297: 2007 Certified Organization) Vol. 4, Issue 5, May 2015

[7] Anup Kumar and R. sabarish. Structural and Thermal Analysis of Brake Deum. Middle East Journal of Scientific Research Vol20. (8). IDOSI Publication. Pp 1012-1016. . 2014

[8] Meenakshi Kushal ,Suman Sharma *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 4 Ver. IV (Jul. - Aug. 2015), PP 70-75*

[9] Yi Zhang, Hu Zhang, and Chao Lu *Research Article* Jingyu Liu, Yuan Feng, Hui Liu, Tao Wang, Xuna Guo, Shuo Zhang @ieee.org.

[10] Jinchun Huang, CharlesM. Krousgrill, Anil K. Bajaj Journal of Sound and Vibration 289 (2006) 245–263

[11] MAXun, ZHANG Jiwei 20IO International Conference on Computer Application and System Modeling (ICCASM 2010)

[12] Mechanical design data book

[13] *Xue-liang Bian, Da Wan* @ieee.org.