

Using the ANSYS Tool, Implement a Gaussian Thermal Boundary Condition Across a Rectangular Plate for Finite Element Analysis

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ABSTRACT

The use of boundary conditions in finite element analysis is crucial for understanding the behavior of any physical model before implementing it in practice. boundary condition methodology applied correctly to any actual object's true behavior in practical applications. Accurate estimation of the location and width parameters of sampled Gaussian functions is necessary in several domains, including Gaussian beam characterization and emission and absorption line spectroscopy. This paper discusses the use of the ANSYS tool to construct the Gaussian thermal barrier in finite element analysis. In this study, a straightforward rectangular plate will be used as an example to apply a thermal boundary condition on its front face.

Index Terms: FEA , MATLAB, ANSYS.

I. INTRODUCTION

A numerical technique used to solve engineering and mathematical physics problems is called finite element analysis (FEA). A computational method for obtaining approximations of solutions to boundary value issues in engineering is called finite element analysis (FEA). Engineering sectors employ Finite Element Analysis as a design tool because of the capability analysis that goes along with the various software packages. Representing thermal boundary conditions, such as the application of a uniform temperature parameter with pieces assembled in both horizontal and vertical orientations, simplifies the issue of thermal error modeling. It was feasible to determine the functional relationship between the mesh element size and the FE results by carrying out a Design of Experiments. The distinction between natural and essential boundary conditions is made via the finite element method. A physical quantity, such as flux in a thermal diffusion problem or stress in a linear elastic problem, is represented by the boundary condition integrands. If the integrands are known, the condition can be directly implemented by substituting, or it can be done by substituting an expression that involves an unknown, such a radiation condition. When the PDE problem is given, the natural boundary condition is specified. Conversely, an essential boundary condition is a strict specification at a certain set of boundary nodes. The goal of this work is to get thermal parameters for the FEA by applying thermal Gaussian temperature to portions of a basic rectangular plate. However, the computer will take longer to provide the analysis's conclusions as the model gets bigger (in FEA, larger models do not necessarily indicate greater geometry; rather, larger models simply signify more complexity due to the amount of elements used). It also gives instructions on how to use the parameters of the Gaussian boundary condition in its mathematical equation. The improvement of FEA thermal boundary condition application, a crucial component of

engineering design, is the relevance of this work. The process and parameters are equally applicable to other aspects of thermodynamic behavior, even if the focus is on any design.

2 METHODOLOGY

When applying boundary conditions in the finite element method, it is necessary to either replace the integrand that results from the second order term with some information or to replace the entire equation with crucial conditions for that test function. Use of boundary conditions It takes the least amount of time, yet it's the most crucial phase. everything else without using the appropriate boundary conditions. Once pre-processing, such as CAD, meshing, and boundary conditions, are finished, software internally creates equations of the form $[F] = [K] [\delta]$. Attempting to formulate the equation is the best course of action because boundary condition integrals frequently have physical meaning. A common pattern found in many second-order equations is time rate change of heat = div(flux). The time rate is 0 in a steady state condition. For initial study boundary condition of temperature apply on the rectangular plate. For example Gaussian distribution of temperature can be define as

$$\text{temperature}(r) = A \cdot e^{-\left(\frac{r}{C}\right)^2} + B \cdot e^{-\left(\frac{r}{D}\right)^2}$$

where the values of A, B, C, and D are constant and r is the beam's radius where the temperature is spread according to the Gaussian curve. MATLAB is a particularly helpful piece of software for linear algebra. A tool for numerical integration differential equation solution is MATLAB. Signal processing, image processing, and optimization can all benefit from the use of MATLAB. It is also one of the simplest programming languages to use when creating mathematical programs. To evaluate the Gaussian curve, first build the Gaussian equation program using the MATLAB tool. This program can then be turned into a MACRO file, as seen in figure 1 below. It is crucial to understand the accuracy of the estimations once an algorithm for estimating the Gaussian function parameters has been developed.

```

Range("D2:F3").Select
Range(Selection, Selection.End(xlDown)).Select
Selection.ClearContents
Range("D2").Select

s = Cells(1, 2).Value
a = Cells(9, 2).Value
b = Cells(10, 2).Value
Mj = Cells(11, 2).Value
Mn = Cells(12, 2).Value
c1 = Cells(13, 2).Value
c2 = Cells(14, 2).Value
l1 = Cells(15, 2).Value
l2 = Cells(16, 2).Value
res = Cells(18, 2).Value
th = Cells(17, 2).Value * (WorksheetFunction.Pi() / 180)

c = 0
x = -7.5
While x <= 11
y = -7.5
While y <= 12

i = (Abs((WorksheetFunction.Round((Abs(x - c1) / a), 0) * a) - (x - c1))) * (Cos(th))
j = Abs((WorksheetFunction.Round((Abs(y - c2) / b), 0) * b) - (y - c2))

r = Sqr((i ^ 2) + (j ^ 2))

If r <= (Mn / 2) Then
c = c + 1
Cells(6, 2).Value = (r / 1000)
Cells(1, 2).Value = s + ((x * Sin(th)) / 1000)
n = Cells(7, 2).Value / Cos(th)
Cells(c + 1, 4) = x
Cells(c + 1, 5) = y
Cells(c + 1, 6) = n
    
```

Fig 1 Macro file in Excel

The program output above creates a data point with a 0.5 megapixel pixel size in a prescribed surface boundary. The temperature value varies according to the function coefficient variation dependent on the r value. As we establish the boundary condition, the entire data point covered by this surface at a pitch of 0.5 mm has a radius of 7 mm. Figure 2 below shows the temperature data generated on x and y coordinate point values. Text data

can be saved in a notepad file. To import this text data file into an external data file with a tab-delimited format for ANSYS interference, select external data from the ANSYS workbench toolbar, as illustrated in figure 4 below.

| | A | B | C | D | E | F |
|----|---|-------------|---|---------------|---------------|-------------|
| 1 | s | 12 | | Co-ordinate X | Co-ordinate Y | PO(y) |
| 2 | A ₁ (s) | 2049578.98 | | -7.5 | 0 | 0.613512408 |
| 3 | C ₁ (s) | 0.005622 | | -7.5 | 32 | 0.613512408 |
| 4 | A ₂ (s) | 12874361.92 | | -7.5 | 64 | 0.613512408 |
| 5 | C ₂ (s) | 0.007722 | | -7 | -2.5 | 0.824449592 |
| 6 | r | 0.0075 | | -7 | -1 | 9.285674133 |
| 7 | PO(y) | 0.613512408 | | -7 | -1.5 | 9.671357888 |
| 8 | | | | -7 | -1 | 9.957625341 |
| 9 | Horizontal Centre Distance | 32.00 mm | | -7 | 0.5 | 10.1338493 |
| 10 | Vertical Centre Distance | 32.00 mm | | -7 | 0 | 10.13384934 |
| 11 | Major Axis | 15.00 mm | | -7 | 0.5 | 10.1338493 |
| 12 | Minor Axis | 15.00 mm | | -7 | 1 | 9.957625341 |
| 13 | Horizontal Distance of origin from first centre | .00 mm | | -7 | 1.5 | 9.671357888 |
| 14 | Vertical Distance of origin from first centre | .00 mm | | -7 | 2 | 9.285674133 |
| 15 | Horizontal Plate Length | 87.50 mm | | -7 | 2.5 | 0.824449592 |

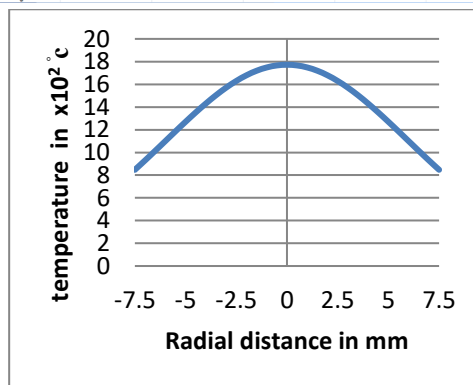


Fig 2 Output macro file data point.

Fig 3 Data point in external data setup

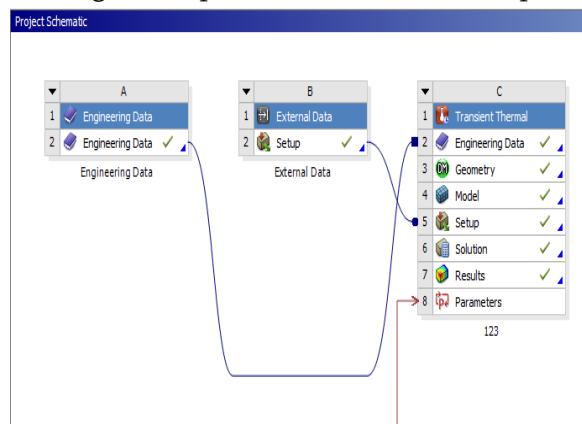


Fig 4 ANSYS interference

3 RESULT AND DISCUSSION:

As we define the Gaussian distribution of any beam using a mathematical expression, we can use a macro tool to transform this mathematical phrase into data in an Excel file. Data output in the form of temperature readings and source point data. The circular face boundary, which is predefined for the implementation of temperature conversion into a number of tiny data points and heat load distribution based on equation result in macro file data, is depicted in the figure below.

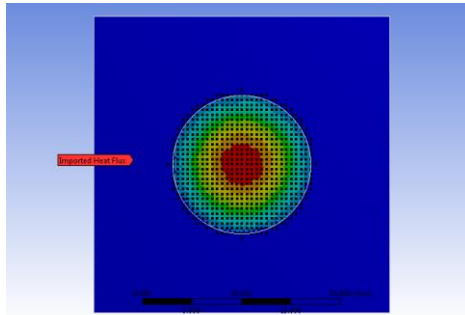


Fig 1.4 Output of Gaussian load on front of rectangular plate with source data

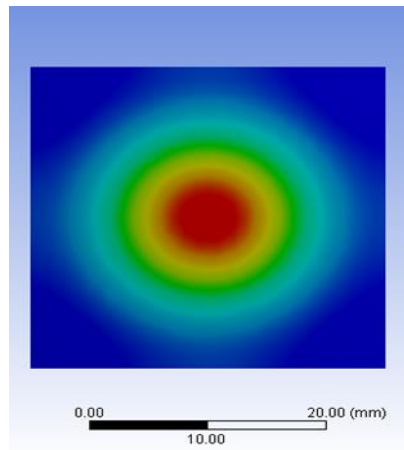


fig 5 heat flux distribution over plate surface

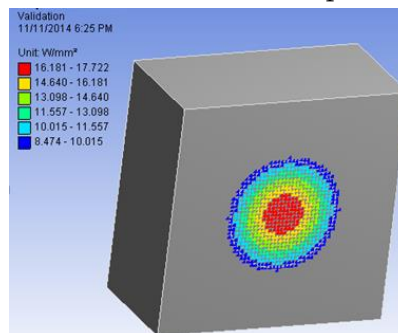


fig 6 validate result of heat flux

Gaussian temperature load situation and heat flux distribution in accordance with the temperature Gaussian curve are depicted in the above figures. in addition to verifying the heat flux value through the circular boundary condition.

4 CONCLUSION:

We may construct a methodology for the implementation of any Gaussian thermal boundary condition for the finite element analysis, as demonstrated in the discussion above in this study. We can create data point values using a MATLAB software and an Excel datasheet, which we can then feed straight into an ANSYS application.

in order to assess the analysis's outcome and transfer any Gaussian load that is in terms of its radial distance to a number of data points on the boundary surface.

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