Thermal Stress Analysis of Functionally Graded Materials (Titanium/Aluminium) By Finite Element Method

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Abstract- *Functionally graded materials (FGMs) are a replacement generation of built materials in which the fabric properties are regularly varied through the thickness direction by mixing 2 totally different materials and therefore no distinct internal boundaries exist and failures from interfacial stress concentrations developed in typical structural parts are usually avoided. FGMs are wide used in several structural applications like mechanics, civil engineering, optical, electronic, chemical, mechanical, biomedical, energy sources, nuclear, automotive fields and ship building industries to eliminate stress concentration and relax residual stresses and enhance bond strength*

In this work stress of FGM plates with a channel are studied underneath Thermal load condition. Material properties are calculated on paper victimization rule of mixtures Total 5 different layer thickness models are studied underneath different variety of layers.

Keywords- Titanium, Alluminium5052, Carbide Layers, Cad, Catia, Ansys

I. INTRODUCTION

FGM is associate absolute material, affiliation to a category of advanced materials with differentiating properties over a varied dimension. FGM occur in nature as teeth and bones etc., designed nature this materials to succeed in their anticipate service essential. this idea is reproduce from nature to resolve engineering complication within the same manner artificial network is employed to breed human brain. FGM removes the sharp interfaces existing in material that is failure is establish. It substitute this sharp interface with a gradient interface which supplies swish transition from one material to the opposite. one distinctive attribute of functionally hierarchal materials is that the capability to tailor a cloth for explicit application.

CLASSIFICATION OF COMPOSITE MATERIALS:

Composites can be classified primarily into two ways. The first way to classify composite materials is by the type of matrix material.

- Polymeric matrix composites(PMCs)
- Metal matrix composites (MMCs)
- Ceramic matrix composites (CMSs)
- Carbon/carbon composites (CCCs)

The second type is based on the geometry and shapes of reinforcements and structural form of composites.

- Phased composites
- Particulate composites
- Short fibre composites
- Flake composites
- Unidirectional composites

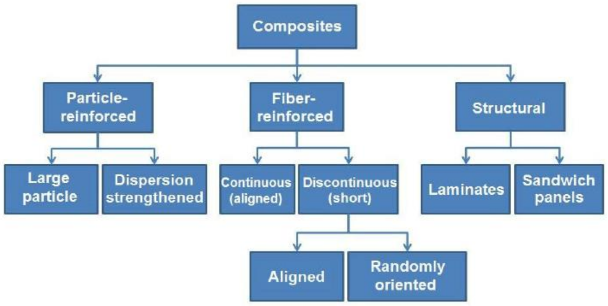
Layered composites

- Laminated composites
- Sandwich composites

II. PROPERTIES OF REINFORCING FIBRES

The four main factors that govern the fibre's contribution are

1. The basic mechanical properties of the fibre itself.
2. The surface interaction of fibre and resin (the 'interface').
3. The amount of fibre in the composite ('Fibre Volume Fraction').
4. The orientation of the fibers in the composite Fiber sheet



REINFORCEMENT:

The role of the reinforcement in a composite material is fundamentally to increase the neat resin system. All of the different fibres used in composites have different properties and so affect the properties of the composite in different ways. Fibre is a class of hair-like materials that are continuous filaments in discrete elongated similar to pieces of thread.

Reinforcement usually prevents crack propagation. Thin fibres can have very high strength, and provided they are mechanically well attached to the matrix and can improve the composite's overall properties. Fibre-reinforced composite materials can be divided into two main categories normally referred to as short fibre-reinforced materials and continuous fibre-reinforced materials.

TECHNIQUES OF FGM (FUNCTIONALLY HIERARCHICAL MATERIALS)

Thin FGM square measure usually within the style of surface coatings, betting on the service demand from the method there square measure a huge vary of surface deposition processes to choose it from.

1. **Vapour Deposition Technique There square measure differing types of vapour deposition techniques, they include:**

CVD (Chemical Vapour Deposition) and PVD (Physical Vapour Deposition) square measure Sputter deposition. each CVD and PVD ways square measure wont to deposit functionally hierarchical surface coatings and that they offer outstanding microstructure, and that they will be used for depositing skinny surface coat. they're manufacture toxic gases and energy intensive as their product. In manufacturing functionally hierarchical coating embody different ways like particle beam assisted Deposition, natural process, plasma spraying, Self-Propagating High-temperature Synthesis, conductor position etc. of these processes can't be wont to manufacture bulk functionally hierarchical materials as a result of as they're usually energy intensive and slow, thus they're uneconomical to be employed in fabricating bulk FGM. From these a number of the fabrication ways for manufacturing bulk FGM square measure as explained.

2. **Powder Metallurgy (PM)**

PM (Powder metallurgy) ability is employed to supply FGM through three basic steps vicelike, intermixture and deliberation of powder consistent with the pre-designed abstraction distribution as set by the useful necessity, stacking and ramming of the premixed-powders, and eventually sintering. If continuous structure is desired then centrifugal methodology is employed. PM technique provides rise to a stepwise structure.

3. **Centrifugal methodology**

Centrifugal methodology is alike to centrifugal casting wherever the ability of gravity is employed on spinning of the mould to make mass FGM. hierarchical material is falsify during this manner owing to the unsimilarity in spinning of the mould and material densities. Different similar procedure like centrifugal methodology within the literature. Whereas continuous grading will be achieved mistreatment centrifugal methodology however solely cylindrical shapes will be fashioned. different complication of centrifugal methodology is that there's boundary to different style of gradient will be created thanks to the gradient is made through activity like force and density distinction. To resolve these issues researchers square measure mistreatment replacement producing methodology like solid freeform.

4. **Solid Freeform (SFF) Fabrication methodology**

SFF is associate degree additive producing method that give a lot of advantages that embody, ability to supply complicated shapes, most material utilization, less energy intensive, higher speed of production, design freedom as elements square measure created directly from laptop assisted design knowledge. Solid freeform needs five basic steps, slicing of the STL into 2 dimensional cross-sectional profiles, conversion of the CAD knowledge to straightforward Triangulation Language (STL) file, generation of CAD knowledge from the package like AutoCAD, Solid edge etc.,

THEORETICAL APPROACHES FOR ESTIMATION OF FGM'S PROPERTIES

An economical approach for theoretical investigation of the dynamic response of cracks in FGMs underneath impact load is given in. Analytical solutions of stress fields in functionally stratified hollow cylinder with finite length subjected to axis cruciform pressure loadings on its inner and outer surfaces area unit given in. Numerical results for stresses within the cylinder at loads are presented.

Two section functionally stratified composites with native try wise particle intercourse for a micromechanics primarily based elastic model is progressed. usually elastic fields area unit receive for shear loading within the gradient direction and crosswise uniaxial.

The process of multi-particle setting within the manufacture of FGMs by co-sedimentation is modelled in. The models may be accustomed style powder composition and to predict the amount fractions obtained in FGMs. As examples, Tic-Ni system FGMs area unit designed and made. The predictions match well the particular results obtained. AN experiment with Mo - Ti system FGM is additionally accustomed validate the prediction model.

Other areas of application are:

- automobile engine elements
- heat money changer
- nuclear reactor elements
- sensors
- cutting tool insert coating
- turbine blade
- Tribology
- Fire retardent doors, etc.

This list of applications is endless and plenty of a lot of applications is turning out because the process technology, properties of FMG and price of production developed.

III. AREAS OF APPLICATION OF FGM

The applications of FGM area unit explained below:

1. FGM in Aerospace: FGM will resist terribly high thermal gradient, this makes it satisfactory to be used in area plane body and rocket part, structures, etc... If process technique is developed, functionally stratified material area unit promising and might be utilized in immense areas of region.

2. FGM in Medicine: Living tissues like teeth and bones area unit characterised as FGM from nature, to substitute these tissues, a similar temperament material is needed that may fulfil the explanation for the first bio-tissue. absolutely the candidate for this application is FGM. Functionally stratified material has found wide selection of request in dental and orthopedical solicitation for bone and teeth replacement.

3. FGM in Defence: It is the foremost necessary characteristics of FGM is that the capability to hamper crack generation. This property makes it purposeful in defence application, as a PRM (penetration resistant materials) used for bullet-proof vests and armour plates.

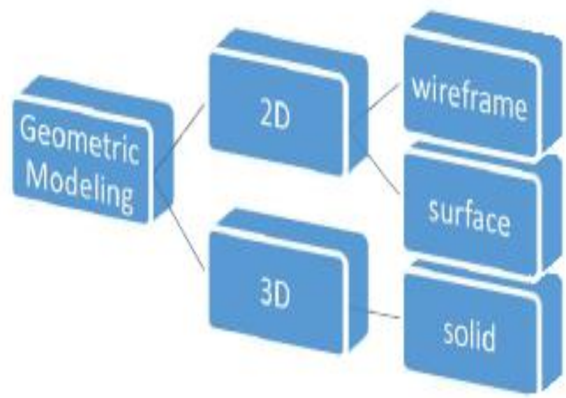
4. FGM in Energy: Functionally stratified material area unit worn in energy conversion devices. They conjointly offer limit and area unit used as protecting coating on rotary engine blades in turbine engine.

5. FGM in Optoelectronics: FGM conjointly finds its application in optoelectronics as stratified ratio materials and in audio-video discs data-storage medium media.

Material

1.Titanium
2.Aluminium 5052

MODELING:



CAD: Computed aided intend (CAD) can be explain as the interest of electronic computer systems in ideate the idea to renew and modify the plan. Computer aided purpose is a preserver in which interaction between schemer and information processing system is made as simple and effective possible.

CATIA second manifold station of outcome growth through formularizing, intend, engineering and manufacturing. CATIA has a unique capability of design a product in the firm of its real life behavior. This purpose software became fruitful since of its technology which facilitates its customers to innovate a untried robust, parametric, form based standard consistently. It is user amicable. Solid and epitomic modeling can be done quietly. As products and expect.

ANSYS

ANSYS is general finite component analysis (FEA) code package. Finite component Analysis could be a numerical methodology of deconstructing a fancy system into terribly little items (of user-designated size) referred to as parts. The code implements equations that govern the behaviour of those parts and solves them all; making a comprehensive rationalization of however the system acts as an entire. These results then is given in tabulated or graphical forms.

CALCULATIONS FOR ALUMINIUM WITH TITANIUM

Properties	Aluminium (metal)	Titanium carbide (ceramic)
Young's modulus (e)	70Gpa	460Gpa
Poisson's ratio (V)	0.3	0.336
Thermal conductivity (K)	204 W/mk	5.64 W/mk
Co-efficient of thermal expansion (α)	$23*10^{-6}$ /k	$7.4*10^{-6}$ /k
Density (ρ)	$2.7*10^{3}$ kg/m^{3}	4930 kg/m^{3}

Layers:

$P(z) = P_2 + (P_1 - P_2) V_1$
V_1= (0.90, 0.8, 0.70, 0.60, 0.50, 0.40, 0.30, 0.20, 0.10)
p1=aluminium, p2=titanium carbide

By taking the values of v1= 0.90

P (e) = 460+ (70−460)* 0.90=109Gpa
P (V) =0.336+ (0.3−0.336)* 0.90=0.3036
P (k) =5.64+ (204−5.64)* 0.90=184.164W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.90=2.144*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.90=2923$Kg/m^{3}

By taking the values of v1= 0.80

P (e) = 460+ (70−460)*0.80 =148Gpa
P (V) =0.336+ (0.3−0.336)* 0.80 =0.3072
P (k) =5.64+ (204−5.64)* 0.80 =164.328W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.80$
$=1.988*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.8=3146$Kg/m^{3}

By taking the values of v1= 0.70

P (e) = 460+ (70−460)* 0.70=187Gpa
P (V) =0.336+ (0.3−0.336)* 0.70=0.3108
P (k) =5.64+ (204−5.64)* 0.70=144.492W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.70=1.832*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.70=3369$Kg/m^{3}

By taking the values of v1= 0.60

P (e) = 460+ (70−460)* 0.60=226Gpa
P (V) =0.336+ (0.3−0.336)* 0.60=0.3144
P (k) =5.64+ (204−5.64)* 0.60=124.656W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.60=1.676*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.60=3592$Kg/m^{3}

By taking the values of v1= 0.50

P (e) = 460+ (70−460)* 0.50=265Gpa
P (V) =0.336+ (0.3−0.336)* 0.50=0.318
P (k) =5.64+ (204−5.64)* 0.50=104.82W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.50=1.52*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.50=3815$Kg/m^{3}

By taking the values of v1= 0.40

P (e) = 460+ (70−460)*0.40=304Gpa
P (V) =0.336+ (0.3−0.336)* 0.40=0.3216
P (k) =5.64+ (204−5.64)* 0.40=84.984W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.40=1.364*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.40=4038$Kg/m^{3}

By taking the values of v1= 0.30

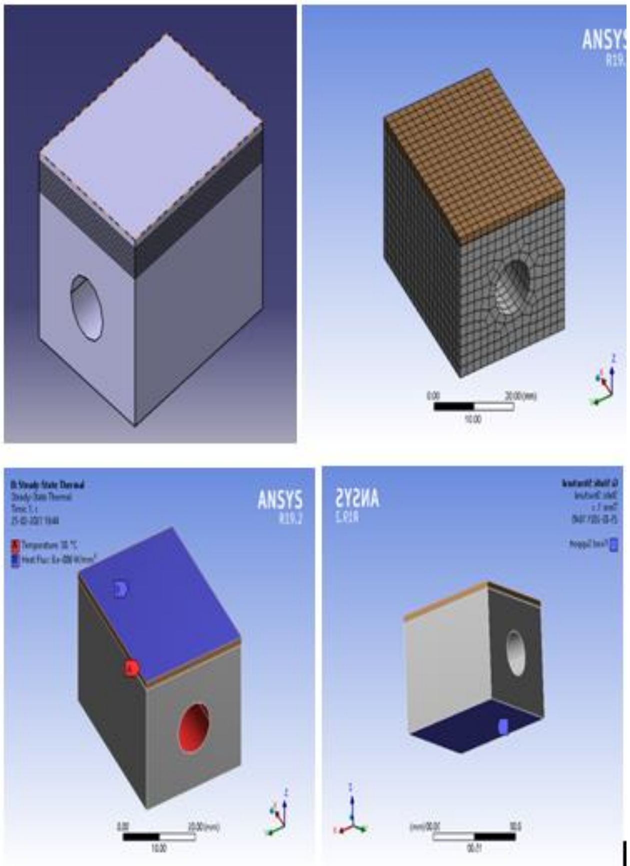
P (e) = 460+ (70−460)*0.30=343Gpa
P (V) =0.336+ (0.3−0.336)* 0.30=0.3252
P (k) =5.64+ (204−5.64)* 0.30=65.148W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.30$
$=1.208*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.30=4261$Kg/m^{3}

By taking the values of v1= 0.20

P (e) = 460+ (70−460)*0.20=382Gpa
P (V) =0.336+ (0.3−0.336)* 0.20=0.3288
P (k) =5.64+ (204−5.64)* 0.20= 45.312W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.20=1.052*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.20=4484$Kg/m^{3}

By taking the values of v1= 0.10

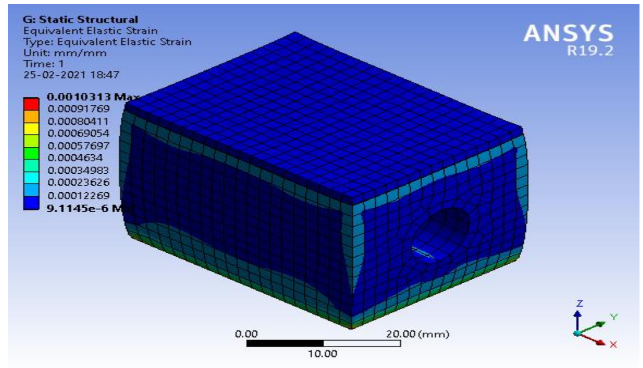
P (e) = 460+ (70−460)*0.10=421Gpa
P (V) =0.336+ (0.3−0.336)* 0.10=0.3324
P (k) =5.64+ (204−5.64)* 0.10= 25.476W/mk
P (α) = $(7.4*10^{-6}) + (23*10^{-6}-7.4*10^{-6})*0.10=8.96*10^{-5}$/K
P (p) = $(4930) + (2.7*10^{3}-4930)*0.10=4707$Kg/m^{3}



Details of "Mesh"	
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	2.0 mm
Sizing	
Use Adaptive Sizi...	Yes
Resolution	Default (2)
Mesh Defeaturing	Yes
Defeature Size	Default
Transition	Fast
Span Angle Center	Coarse
Initial Size Seed	Assembly
Bounding Box Di...	56.66 mm
Average Surface ...	601.13 mm²
Minimum Edge L...	0.1 mm
Quality	
Check Mesh Qua...	Yes, Errors
Error Limits	Standard Mechanical
Target Quality	Default (0.050000)
Smoothing	Medium
Mesh Metric	None
Inflation	
Use Automatic In...	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Lay...	5
Growth Rate	1.2
Inflation Algorit...	Pre
View Advanced ...	No
Advanced	
Statistics	
Nodes	21230
Elements	4080

Results for case 1 with Aluminium/Titanium carbide layer thickness 0.1mm layer count 1 no's

Pictures showing min/max values from equivalent strain



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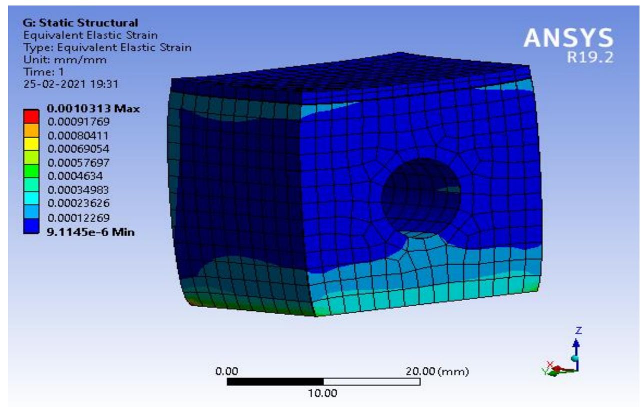
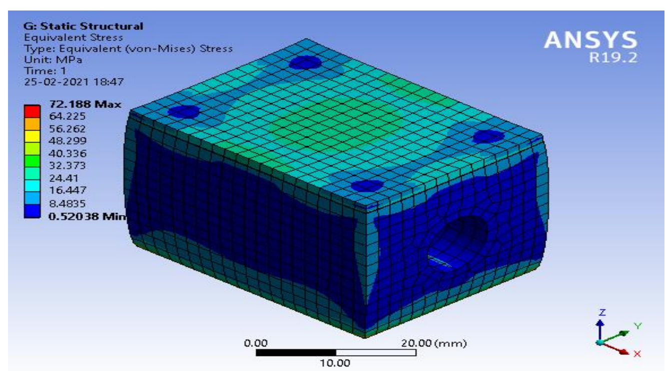
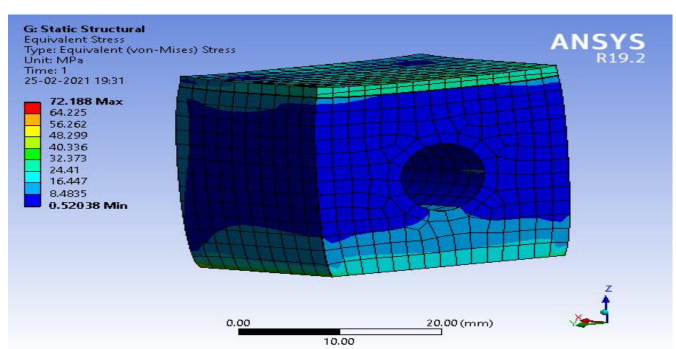


Cut section

Pictures showing min/max values from equivalent stress



Compenent



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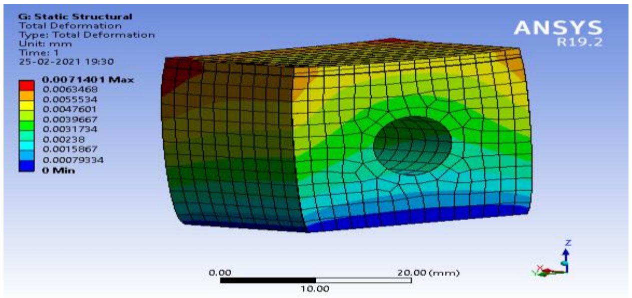
Pictures showing min/max values from total deformation



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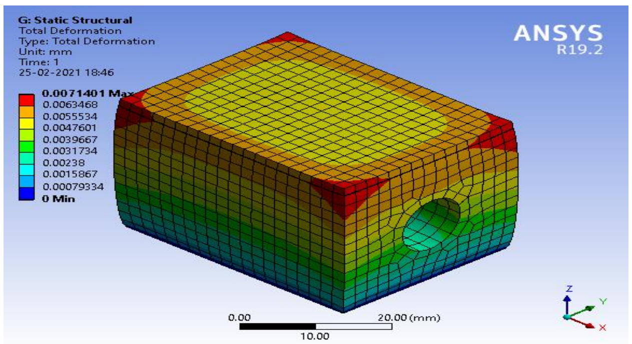

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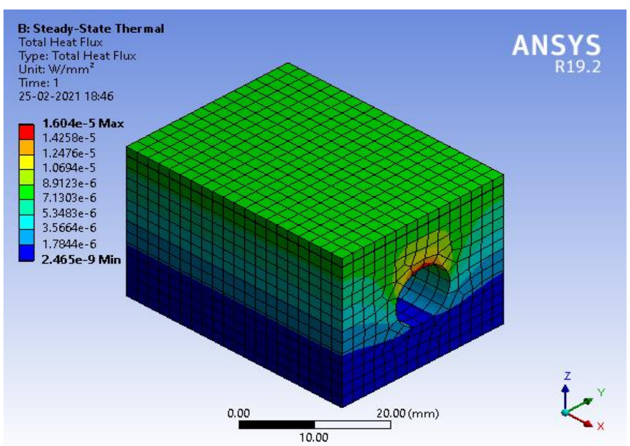
Pictures showing min/max values from total heat flux



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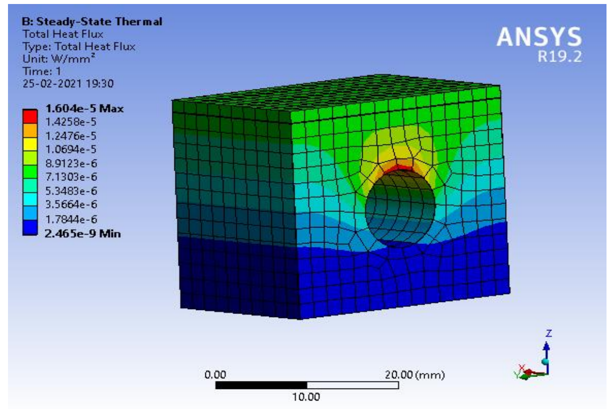

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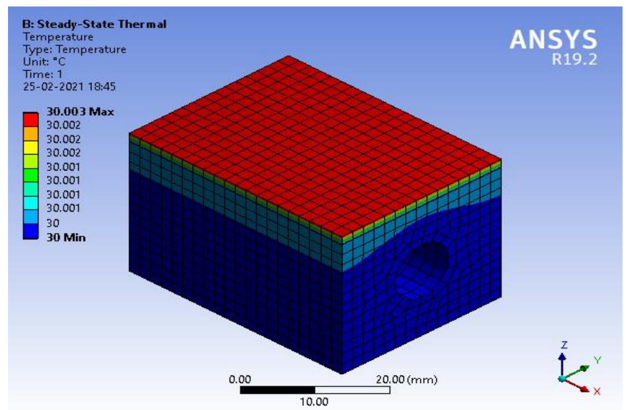
Pictures showing min/max values from temperature



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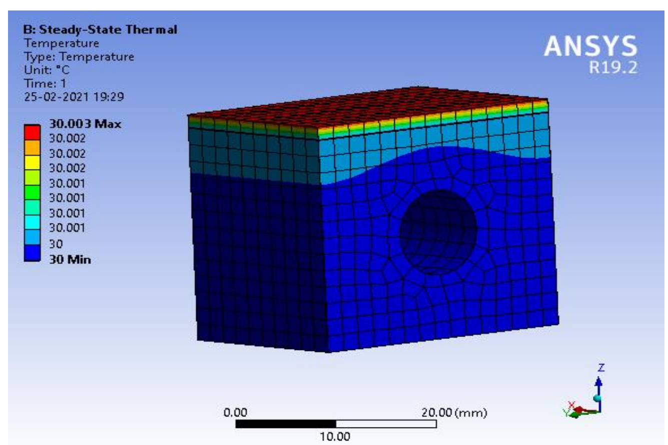

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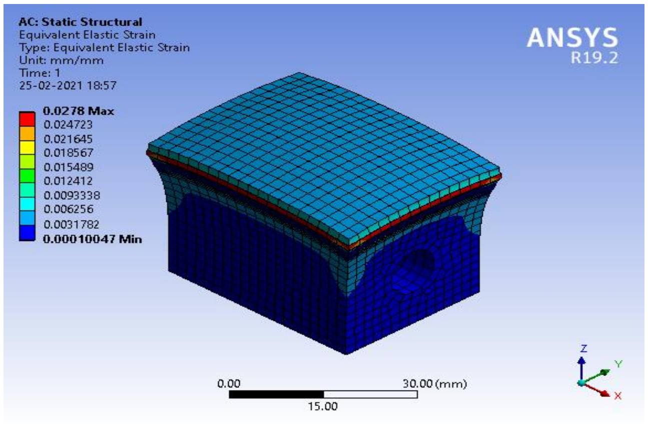
Results for case 15 with Aluminium/Titanium carbide layer thickness 0.5mm layer count 9 no's

Pictures showing min/max values from equivalent strain



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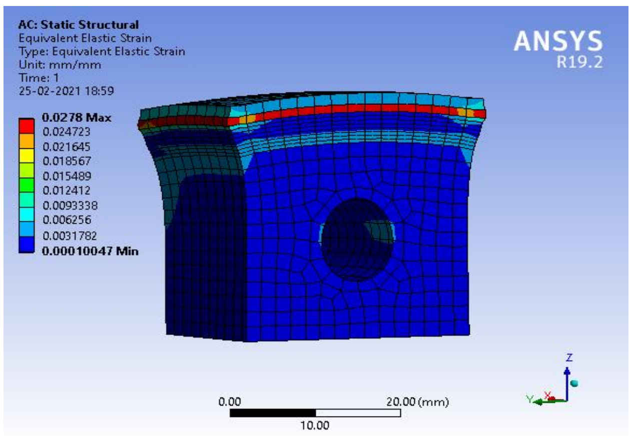

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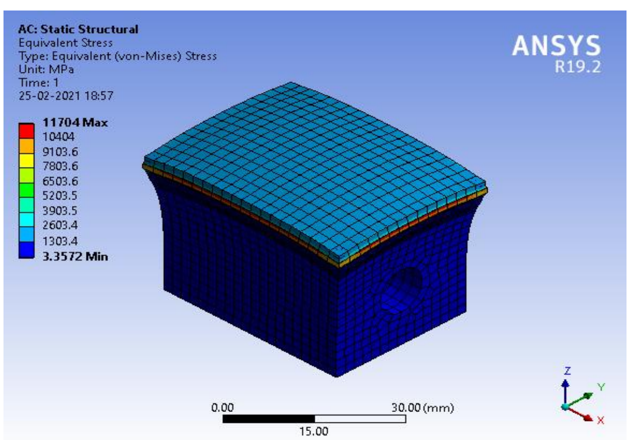
Pictures showing min/max values from equivalent stress



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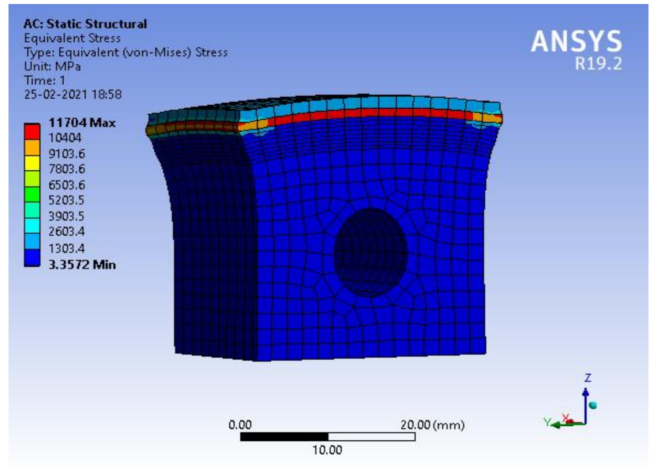

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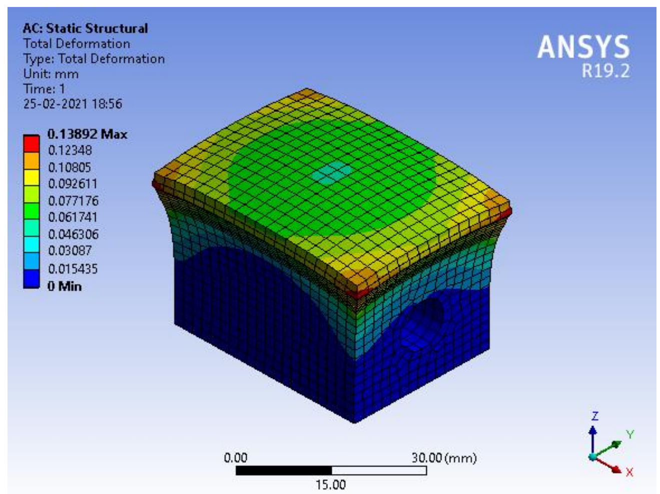
Pictures showing min/max values from total deformation



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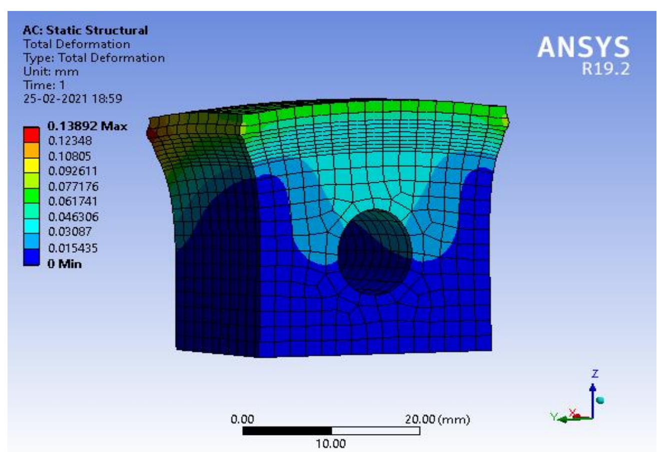

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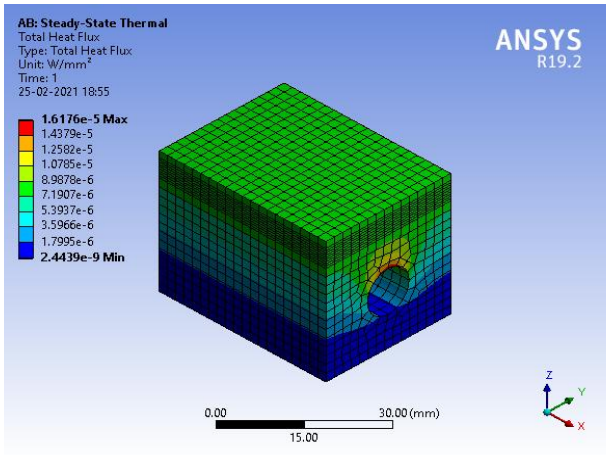
Pictures showing min/max values from total heat flux



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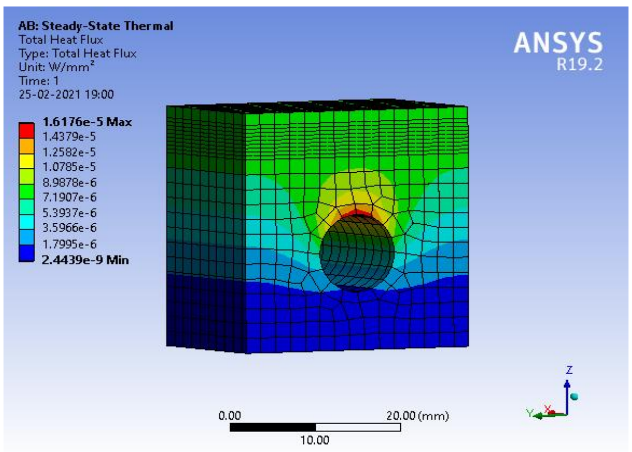

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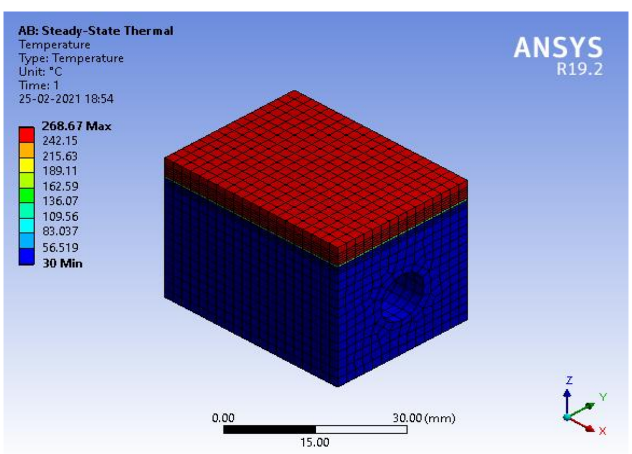
Pictures showing min/max values from temperature



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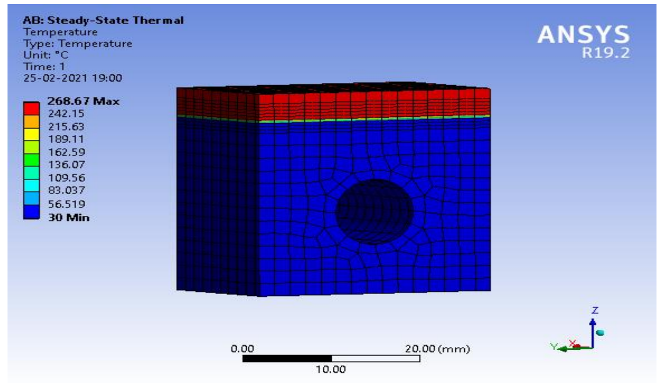

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IV. RESULTS FROM ANSYS

Thermal analysis results

Thermal analysis	Temperature (°C)			Total Heat Flux (W/mm²)			Directional Heat Flux (W/mm²)		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
.1x1	3.00E+01	3.00E+01	3.00E+01	2.47E-09	1.60E-05	4.44E-06	-1.33E-08	1.33E-08	-7.57E-15
.1x4	3.00E+01	3.00E+01	3.00E+01	1.40E-14	1.61E-05	3.48E-06	-1.33E-08	1.33E-08	1.06E-14
.1x9	3.00E+01	3.00E+01	3.00E+01	2.24E-14	1.61E-05	2.40E-06	-4.36E-07	4.36E-07	-3.85E-14
.2x1	3.00E+01	3.00E+01	3.00E+01	2.46E-09	1.60E-05	5.24E-06	-1.33E-08	1.33E-08	-5.73E-16
.2x4	3.00E+01	1.25E+02	5.71E+01	2.46E-09	1.61E-05	5.91E-06	-1.33E-08	1.33E-08	-3.14E-13
.2x9	3.00E+01	1.25E+02	6.58E+01	2.46E-09	1.61E-05	6.52E-06	-1.34E-08	1.34E-08	-7.53E-13
.3x1	3.00E+01	3.00E+01	3.00E+01	2.46E-09	1.61E-05	5.23E-06	-1.33E-08	1.33E-08	5.09E-15
.3x4	3.00E+01	1.73E+02	7.07E+01	2.46E-09	1.61E-05	5.91E-06	-1.34E-08	1.34E-08	-2.26E-13
.3x9	3.00E+01	1.73E+02	8.37E+01	2.45E-09	1.61E-05	6.51E-06	-1.34E-08	1.34E-08	-9.52E-13
.4x1	3.00E+01	3.00E+01	3.00E+01	2.46E-09	1.61E-05	5.23E-06	-1.34E-08	1.34E-08	-4.47E-15
.4x4	3.00E+01	2.21E+02	8.43E+01	2.38E-09	1.76E-05	6.26E-06	-1.37E-08	1.37E-08	-9.40E-13
.4x9	3.00E+01	2.21E+02	1.02E+02	2.45E-09	1.62E-05	6.51E-06	-1.34E-08	1.34E-08	-9.02E-13
.5x1	3.00E+01	2.94E+02	6.27E+01	2.46E-04	1.61E+00	5.23E-06	-1.34E-03	1.34E-03	6.55E-12
.5x4	3.00E+01	2.69E+02	9.78E+01	2.46E-09	1.61E-05	5.91E-06	-1.34E-08	1.34E-08	-3.39E-13
.5x9	3.00E+01	2.69E+02	1.20E+02	2.44E-09	1.62E-05	6.51E-06	-1.34E-08	1.34E-08	-5.88E-13

Structural analysis results

Structural analysis	Total Deformation (mm)			Equivalent Elastic Strain (mm/mm)			Equivalent (von-Mises) Stress (Mpa)		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
.1x1	0.00E+00	7.14E-03	3.89E-03	9.11E-06	1.03E-03	1.06E-04	5.20E-01	7.22E+01	1.05E+01
.1x4	0.00E+00	6.98E-03	4.31E-03	1.11E-05	1.03E-03	9.77E-05	5.76E-01	7.21E+01	1.32E+01
.1x9	0.00E+00	7.11E-03	5.01E-03	7.76E-06	8.91E-04	1.16E-04	2.57E-01	1.57E+02	2.46E+01
.2x1	0.00E+00	7.12E-03	5.60E-03	6.17E-06	1.03E-03	1.05E-04	2.01E-01	7.23E+01	1.01E+01
.2x4	0.00E+00	1.96E-02	1.34E-02	8.38E-06	1.58E-03	4.50E-04	1.75E+00	3.56E+02	8.58E+01
.2x9	0.00E+00	3.71E-02	1.35E-02	3.42E-05	1.20E-02	1.46E-03	1.69E+00	5.07E+03	4.30E+02
.3x1	0.00E+00	7.29E-03	3.89E-03	5.83E-06	1.03E-03	1.04E-04	1.74E-01	7.23E+01	1.00E+01
.3x4	0.00E+00	3.02E-02	9.88E-03	4.90E-05	2.29E-03	6.63E-04	1.77E+00	5.18E+02	1.25E+02
.3x9	0.00E+00	6.60E-02	2.13E-02	7.05E-05	1.72E-02	2.20E-03	6.70E-01	7.22E+03	6.51E+02
.4x1	0.00E+00	7.31E-03	3.89E-03	5.98E-06	1.03E-03	1.04E-04	2.20E-01	7.23E+01	9.94E+00
.4x4	0.00E+00	3.00E-02	7.18E-03	2.22E-05	3.88E-03	9.24E-04	8.26E+00	9.02E+02	2.83E+02
.4x9	0.00E+00	1.00E-01	3.02E-02	1.16E-04	2.24E-02	2.97E-03	3.02E+00	9.41E+03	8.81E+02
.5x1	0.00E+00	3.21E-02	1.16E-02	5.31E-05	2.03E-03	3.88E-04	3.16E+00	5.83E+02	7.01E+01
.5x4	0.00E+00	5.32E-02	1.55E-02	5.48E-05	3.66E-03	1.08E-03	2.74E+00	8.27E+02	1.99E+02
.5x9	0.00E+00	1.39E-01	3.98E-02	1.00E-04	2.78E-02	3.75E-03	3.36E+00	1.17E+04	1.12E+03

Static structural values for one layer models

Structural analysis	Total Deformation (mm)	Equivalent Elastic Strain (mm/mm)	Equivalent (von-Mises) Stress (Mpa)
.1x1	3.89E-03	1.06E-04	1.05E+01
.2x1	5.60E-03	1.05E-04	1.01E+01
.3x1	3.89E-03	1.04E-04	1.00E+01
.4x1	3.89E-03	1.04E-04	9.94E+00
.5x1	1.16E-02	3.88E-04	7.01E+01

Thermal values for one layer models

Thermal analysis	Temperature (°C)	Total Heat Flux (W/mm²)	Directional Heat Flux (W/mm²)
.1x1	3.00E+01	4.44E-06	-7.57E-15
.2x1	3.00E+01	5.24E-06	-5.73E-16
.3x1	3.00E+01	5.23E-06	5.09E-15
.4x1	3.00E+01	5.23E-06	-4.47E-15
.5x1	6.27E+01	5.23E-06	6.55E-12

static structural values for four layer models

Structural analysis	Total Deformation (mm)	Equivalent Elastic Strain (mm/mm)	Equivalent (von-Mises) Stress (Mpa)
.1x4	4.31E-03	9.77E-05	1.32E+01
.2x4	1.34E-02	4.50E-04	8.58E+01
.3x4	9.88E-03	6.63E-04	1.25E+02
.4x4	7.18E-03	9.24E-04	2.83E+02
.5x4	1.55E-02	1.08E-03	1.99E+02

Thermal values for four layer models

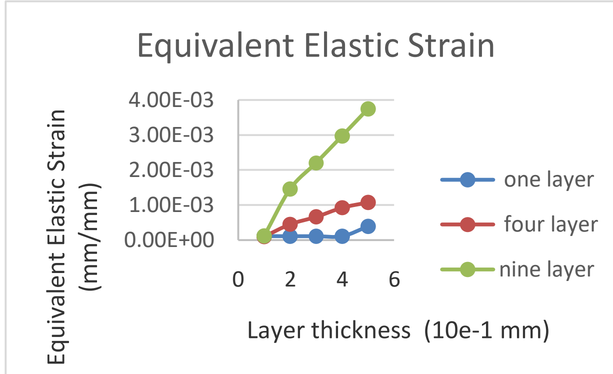
Thermal analysis	Temperature (°C)	Total Heat Flux (W/mm²)	Directional Heat Flux (W/mm²)
.1x4	3.00E+01	3.48E-06	1.06E-14
.2x4	5.71E+01	5.91E-06	-3.14E-13
.3x4	7.07E+01	5.91E-06	-2.26E-13
.4x4	8.43E+01	6.26E-06	-9.40E-13
.5x4	9.78E+01	5.91E-06	-3.39E-13

Static structural values for nine layer models

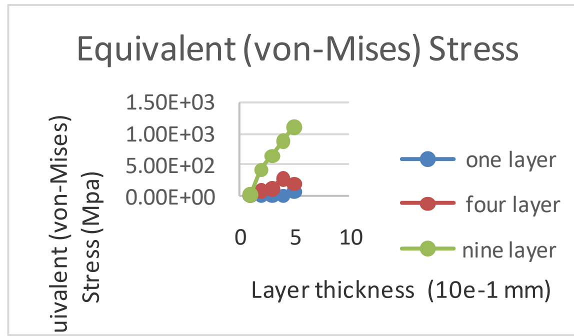
Structural analysis	Total Deformation (mm)	Equivalent Elastic Strain (mm/mm)	Equivalent (von-Mises) Stress (Mpa)
.1x9	5.01E-03	1.16E-04	2.46E+01
.2x9	1.35E-02	1.46E-03	4.30E+02
.3x9	2.13E-02	2.20E-03	6.51E+02
.4x9	3.02E-02	2.97E-03	8.81E+02
.5x9	3.98E-02	3.75E-03	1.12E+03

Thermal values for nine layer models

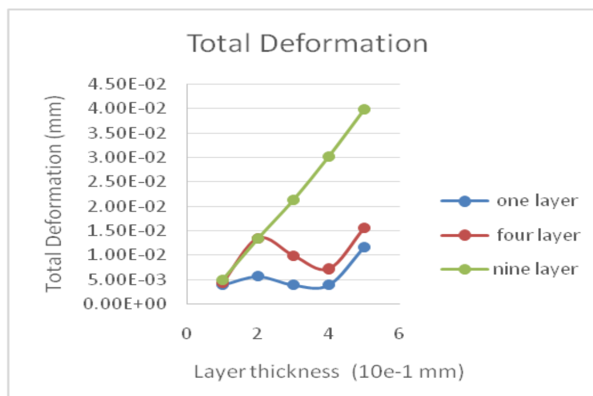
Thermal analysis	Temperature (°C)	Total Heat Flux (W/mm²)	Directional Heat Flux (W/mm²)
.1x9	3.00E+01	2.40E-06	-3.85E-14
.2x9	6.58E+01	6.52E-06	-7.53E-13
.3x9	8.37E+01	6.51E-06	-9.52E-13
.4x9	1.02E+02	6.51E-06	-9.02E-13
.5x9	1.20E+02	6.51E-06	-5.88E-13



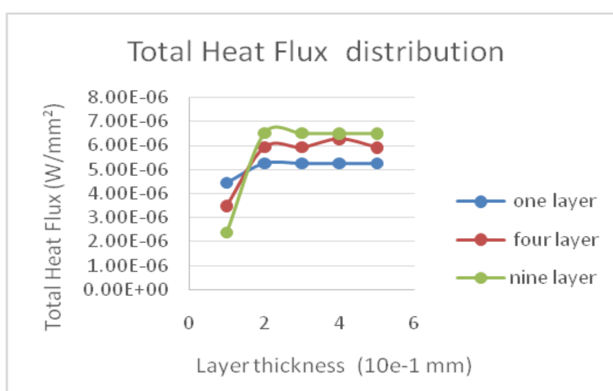
Equivalent strain



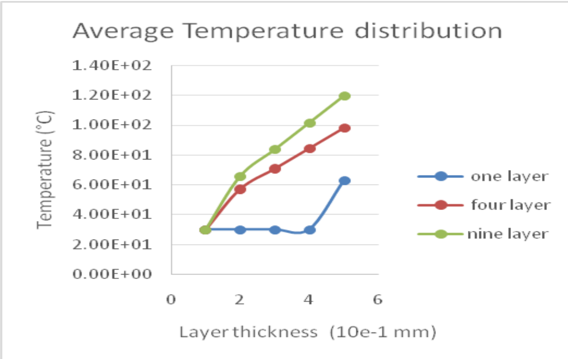
equivalent stress



Total deformation



Total heat flux



Temperature distribution

V. CONCLUSION

thermal, and structural behaviour of element created of functionally stratified materials are studied victimisation Ansys simulation tool. Material properties for the study are calculated victimisation on the market formulation from literature. Total fifteen models are studied for thermal stress and deformations .the main objective is to look at the changes in thermal and structural behaviour of the thing, once the fabric distribution pattern is altered. during this work the behaviour of 2 completely different material distribution patterns are compared. the subsequent observations are made of the study.

Fluxes behavior hasn't modified drastically, however the fluxes have augmented with layer count. most fluxes occurred in 9 layer configuration models no matter the thickness. It clearly indicates that gradual amendment in composition can facilitate in up the warmth transmission.

The temperature distribution is high in 9 bedded models and also the layer thickness is additionally accounted here i.e., the common temperatures augmented with increase in layer thickness

As thermal expansions are a perform of materials the deformations, stress, and strains are augmented with each layer thickness and layer count most stresses are recorded in 9 bedded models and minimum in single bedded models similar trends are shown in strains additionally.

Models with four layers and zero.3 millimeter thickness have the simplest of beat our observation.

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