**Project Report**

**AE681A**

COMPOSITE MATERIALS

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**Ph.D. - AE**

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**QUESTION**

**Given Material Properties of Fiber and Matrix**

**Material ID – 7**

|  |  |
| --- | --- |
| Fibre type | E-glass 21xK43 Gevetex |
| Longitudinal modulus, E1 (GPa) | 80 |
| Transverse modulus, E2 (GPa) | 80 |
| In-plane shear modulus, G12 (GPa) | 33.33 |
| Major Poisson’s ratio, ν12 | 0.2 |
| Transverse shear modulus, G23 (GPa) | 33.33 |
| Longitudinal thermal coefficient, α1 (10−6 /°C) | 4.9 |
| Transverse thermal coefficient, α2 (10−6 /°C) | 4.9 |

|  |  |
| --- | --- |
| Matrix type | MY750/HY917/ DY063 epoxy |
| Modulus, Em (GPa) | 3.35 |
| Poisson’s ratio, νm | 0.35 |
| Thermal coefficient, αm (10−6 /°C) | 58 |

**Volume Fraction – 0.5**

**Load – Displacement**

**ABAQUS MODELING**

**Matrix:**

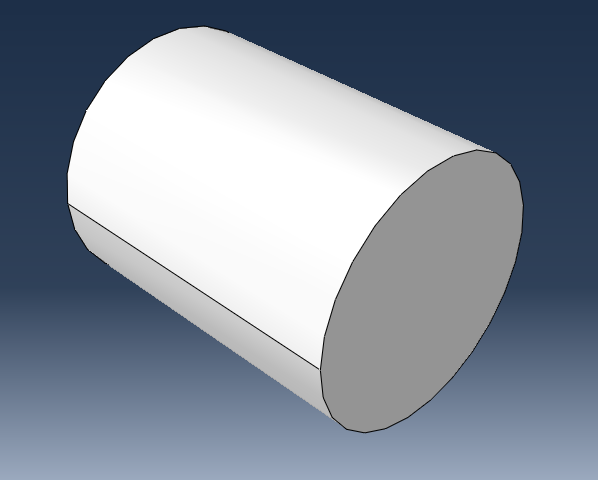
**Icon

Description automatically generated**

**Dimensions:**

**Length = breadth = Height = 2 mm**

**Fibre:**

****

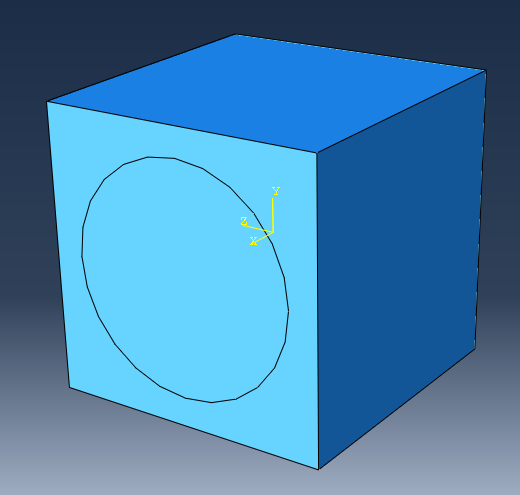
**Dimensions:**

**Length – 2 mm**

**Volume fraction = 0.5**

**Thus, Radius = = 0.79788456 mm**

**Assembly:**

****

**Merge the two objects in the assembly such that the intersecting boundaries are retained**

**Assigning properties:**

**Fibre:**

**E1 = 80000**

**E2 = 80000**

**E3 = 80000**

**Nu12 = 0.2**

**Nu13 = 0.2**

**Nu23 = 0.2**

**G12 = 33330**

**G13 = 33330**

**G23 = 33330**

**Alpha1 = 4.9\*10^-6**

**Alpha2 = 4.9\*10^-6**

**Matrix:**

**E = 3350**

**Nu = 0.35**

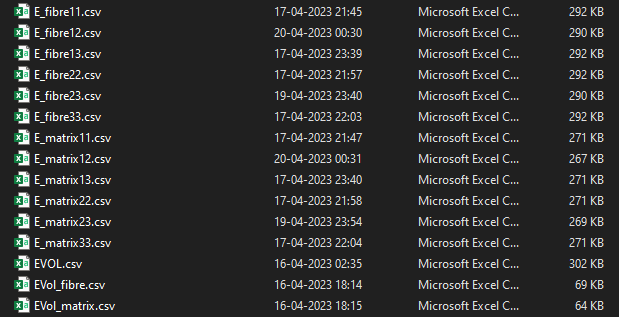
**Alpha = 58\*10^-6**

**Mesh**

**A picture containing container

Description automatically generated**

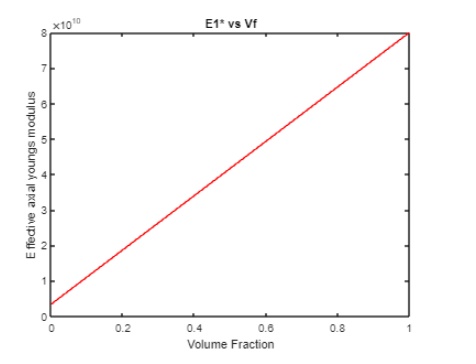
**Apply loads to obtain the following outputs (Ref: attached files)**

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**OBSERVATIONS**

1. **Strength of Materials Approach:**

**E1 vs Vf**

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**V21  vs Vf**

**Chart, line chart

Description automatically generated**

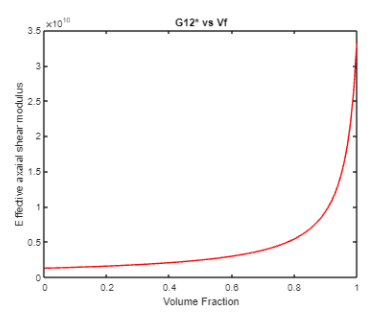
**E2 vs Vf  (1. when deformation in direction 1 is not considered and 2. when deformation in direction 1 is also considered)**

A picture containing diagram

Description automatically generated **A picture containing chart

Description automatically generated**

**G12 vs Vf**

****

**Alpha vs Vf**

**Chart, line chart

Description automatically generated** **A picture containing chart

Description automatically generated**

1. **CCA:**

**E1 vs Vf**

**Chart, line chart

Description automatically generated**

**V21  vs Vf**

**Chart, line chart

Description automatically generated**

**G12 vs Vf**

**Chart

Description automatically generated**

**G23 vs Vf (3 phase model)**

Chart, line chart

Description automatically generated

**K 23 vs Vf**

**Chart, line chart

Description automatically generated**

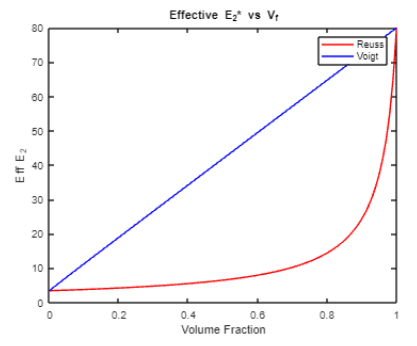
1. **Voigt and Reuss Approximation**

**E1 vs Vf**

**Chart, line chart

Description automatically generated**

**E2 vs Vf**

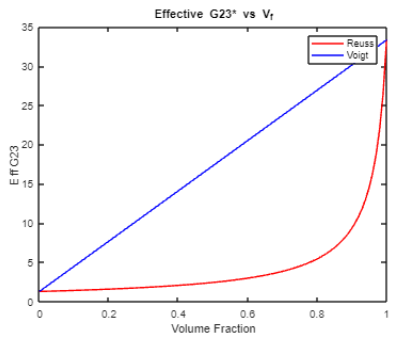
****

**G12 vs Vf**

**Chart, line chart

Description automatically generated**

**G23 vs Vf**

****

**v12 vs Vf**

**A picture containing chart

Description automatically generated**

**v23 vs Vf**

**A picture containing chart

Description automatically generated**

1. **SELF CONSISTENT METHOD**

**G12 vs Vf**

**Chart, line chart

Description automatically generated**

**G23 vs Vf**

**Chart, box and whisker chart

Description automatically generated**

**Since, G23 = 0 throughout in this method, other properties which are dependent on G23 through the implicit relations will also be inaccurate. Hence not included here.**

1. **MORI TANAKA METHOD**

**G12 vs Vf**

**Chart

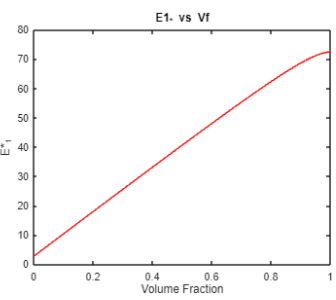
Description automatically generated with medium confidence**

**G23 vs Vf**

**Chart

Description automatically generated**

**E1 vs Vf**

****

**v12 vs Vf**

**Chart, line chart

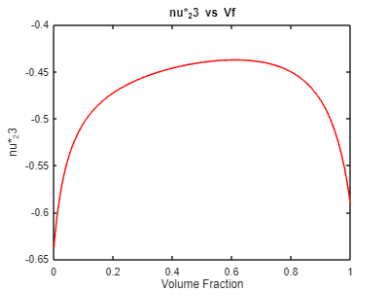
Description automatically generated**

**E2 vs Vf**

**Chart

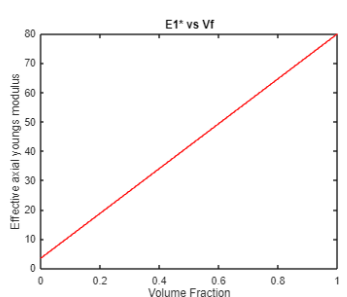
Description automatically generated**

**v23 vs Vf**

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1. **Halpin Tsai Method**

**E1 vs Vf**

****

**v12 vs Vf**

**Chart, line chart

Description automatically generated**

**M vs Vf**

**Chart

Description automatically generated with medium confidence**

1. **Hashin Strickman Bounds**

**E1 vs Vf**

**Chart, line chart

Description automatically generated**

**v12 vs Vf**

**Chart, line chart

Description automatically generated**

**G12 vs Vf**

**Chart, line chart

Description automatically generated**

**G23 vs Vf**

**Chart

Description automatically generated**

**E2 vs Vf**

**Chart

Description automatically generated**

**v23 vs Vf**

**Chart

Description automatically generated**

1. **Hills Concentration Factor Approach**

**Graphical user interface

Description automatically generated with low confidence**

**CONCLUSION / INFERENCE**

* **Self consistent method could not be successfully employed to calculate the effective properties as the Solution of the implicit equation for G23 was giving complex roots. Since some of the other quantities were dependent on the value of G23, more than one quantity was unable to be found out.**
* **G23 for 3 phase model could be calculated for volume fractions of fibre upto around 0.5. After which it showed complex values.**

**A picture containing table

Description automatically generated**

* **The upper and lower bounds of Hashin Strickman method to find out E1 almost coincides and is linear.**
* **E2 and v23 in Hashin strickman method shoots up at around a volume fraction of fibre: 0.2.**
* **The bounds in Effective properties can be clearly visualised in case of Hashin Strickman and Voigt-Reuss Approximation.**