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RESEARCH ARTICLE

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ANALYSIS OF STRESS CONCENTRATION FACTORS IN COMPONENT HAVING NOTCH

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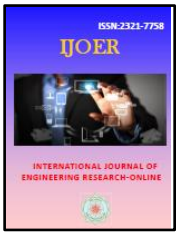

ABSTRACT

A stress concentration (often called stress raisers) is a location in an object where stress is concentrated. The structure is strongest when force is evenly distributed over its area. Discontinuity in geometry, reduction in area or joint locations results in a localized increase in stress when subjected to external loading. The structure can fail due to such stress concentration, when a concentrated stress exceeds the material's strength. The real fracture strength of a material is always lower than the theoretical value because most structural components or assemblies contain discontinuity in geometry or joints which induces stress concentration.

In this project, calculated stress concentration factor when a component having notch in different condition such as single edge notch, double edge notch, central edge notch, central inclined notch.

Key words: Stress Concentration Factor, Notch, Single Edge Notch, Double Edge Notch, Central Normal Notch, And Central Inclined Notch, and ANSYS.

1. Introduction

Stress concentration factor is a dimensionless factor that is used to quantify how concentrated the stress is in a material.

Stress concentration (Kt) = $\frac{\text{maximum stress}}{\text{nominal stress}}$

The stress concentration problem of notches, as shown in figure is often encountered in structural components. This can be overcome by testing the stress concentration factor of the notches by placing them in different ways.

They are Case I : SEN (Single Edged Notch)
Case II : DEN (Double Edged Notch)
Case III : CNN (Central Normal Notch)
Case IV : CIN (Central Inclined Notch)

S.No	Properties	Quantity
1	Length	210mm
2	Width	30.9mm
3	Thickness	2.7mm
4	Notch length	2a mm

I) SEN (Single Edged Notch)

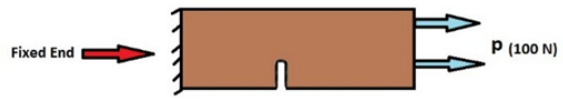

Fig: 2.1 SEN

II) DEN (Double Edged Notch)

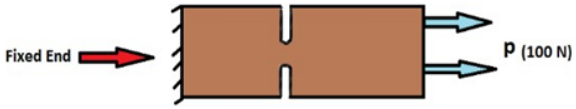

Fig: 2.2 DEN

III) CNN (Central Normal Notch

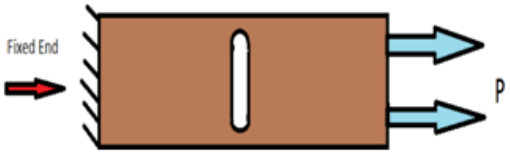

Fig: 2.3 CNN

IV) CIN (Central Inclined Notch)

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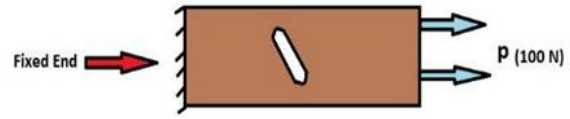

Fig : 2.4 CIN

2. ANSYS Modelling:

ANSYS is a general purpose finite element modeling package for numerically solving a wide variety of mechanical problems. These problems include static dynamic, structural analysis (both linear and nonlinear) heat transfer, and fluid problems, as well as acoustic and electromagnetic problems.

Initially enter Engineering data of the material (e-glass) such as x, y, z properties, Poissions ratio, Density, Shear modulus, Young's modulus.

In all the cases length, width, thickness is constant but notch length varies. The dimensions given to notch length are 6 mm,9 mm,12 mm,15 mm in all cases like SEN, DEN, CNN, CIN. Firstly prepare model and generate meshing with proper meshing size. After that give the boundary condition i.e one end is fixed and another end is loaded. And then click on the solution information and insert Equivalent stress (Von-moises stress).

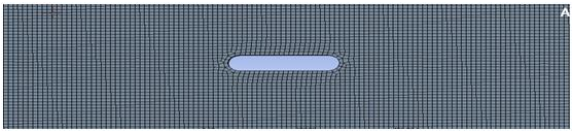

Fig 2.1 Meshing

Table 2.1 Engineering data

1	Density	1970
2	Longitudinal modulus E1	41e03
3	Trnsvers in plane modulus E2	10.4e03
3	Trnsvers out of plane modulus E3	10.4e03
4	In-plane shear modulus, G12	4.3e03
4	Out-of-plane shear modulus, G23	3.5e03
5	Out-of-plane shear modulus, G13	4.3e03
6	Major in-plane possion's ratio, V12	0.28
7	Out-of-plane possion's ratio, V23	0.50
8	Out-of-plane possion's ratio, V13	0.28

The notch lengths are 6,9,12,15. The results are obtained by clicking on the solution information.

Stress concentration (Kt) = $\frac{\text{maximum stress}}{\text{nominal stress}}$

3. Results and discussion:

Case I: Stress Concentration Factor for SEN (Single Edged Notch) specimens:

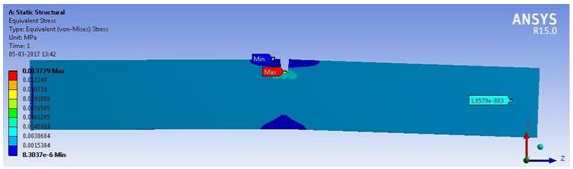

Fig 3.1 Single Edged Notch of length 6 mm

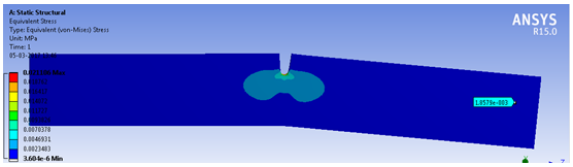

Fig 3.2 Single Edged Notch of length 9 mm

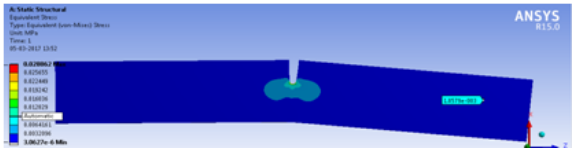

Fig 3.3 Single Edged Notch of length 12 mm

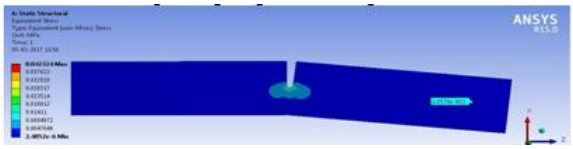

Fig 3.4 Single Edged Notch of length 15 mm

For specimen of notch length 06 = 0.013779/1.857e-3 = 7.42

For specimen of notch length 09 = 0.021106/1.857e-3 = 11.36

For specimen of notch length 12 = 0.028862/1.857e-3 = 15.54

For specimen of notch length 15 = 0.042324/1.857e-3 = 22.7

Case II: Stress Concentration Factor for Double Edged Notch (DEN) specimens

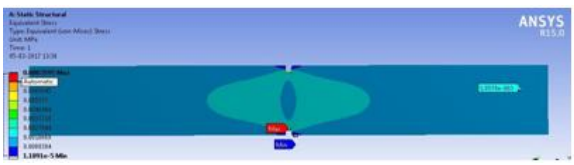

Fig 3.5 Double Edged Notch of length 6 mm

Fig 3.6 Double Edged Notch of length 9 mm

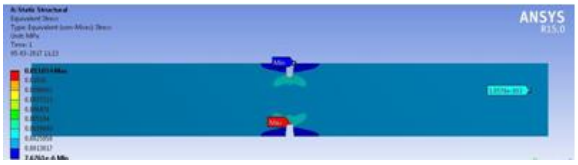

Fig 3.7 Double Edged Notch of length 12 mm

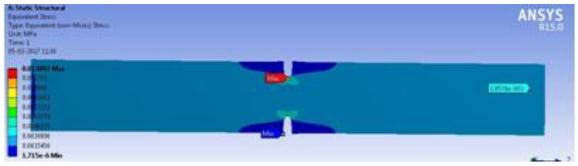

Fig 3.8 Double Edged Notch of length 15 mm

For specimen of notch length 06 = 0.0083595/1.857e-3 = 4.501

For specimen of notch length 09 = 0.010084/1.857e-3 = 5.4302

For specimen of notch length 12 = 0.011654/1.857e-3 = 6.27571

For specimen of notch length 15 = 0.013897/1.857e-3 = 7.4835

Case III : Stress Concentration Factor for CNN(Central Normal Notch) specimens:

Fig 3.9 Central Normal Notch of length 6 mm

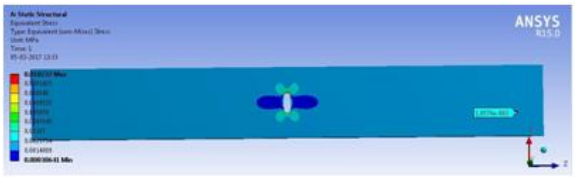

Fig 3.10 Central Normal Notch of length 9 mm

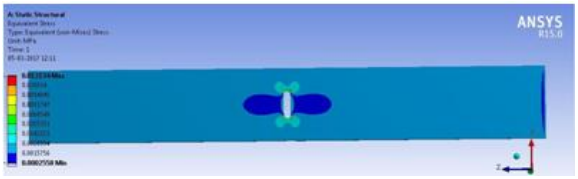

Fig 3.11 Central Normal Notch of length 12 mm

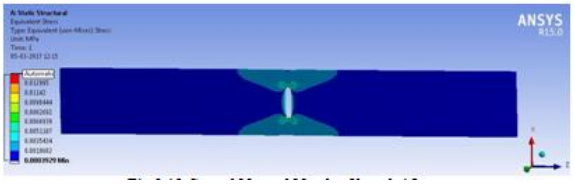

Fig 3.12 Central Normal Notch of length 15 mm

For specimen of notch length 06 = 0.0084086/1.857e-3 = 4.59486

For specimen of notch length 09 = 0.010237/1.857e-3 = 5.51028

For specimen of notch length 12 = 0.012134/1.857e-3 = 6.551

For specimen of notch length 15 = 0.01457/1.857e-3 = 7.845

Case IV : Stress Concentration Factor for CIN(Central Inclined Notch) specimens:

The notch lengths are 6,9,12,15. The results are obtained by clicking on the solution information and made with different angles like 15,30,45,60,75,90.

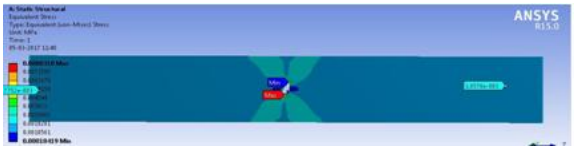

Fig 3.13 Central Inclined Notch of length 6 mm of angle 15

Fig 3.14 Central Inclined Notch of length 6 mm of angle 30

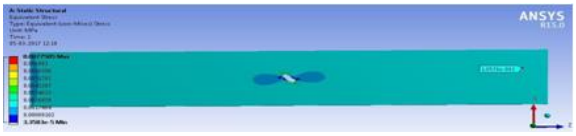

Fig 3.15 Central Inclined Notch of length 6 mm of angle 45

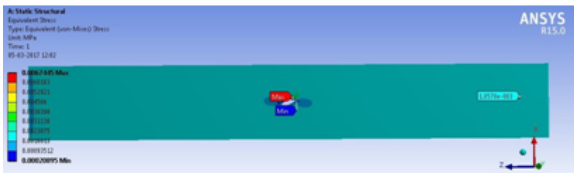

Fig 3.16 Central Inclined Notch of length 6 mm of angle 60

Fig 3.17 Central Inclined Notch of length 6 mm of angle 75

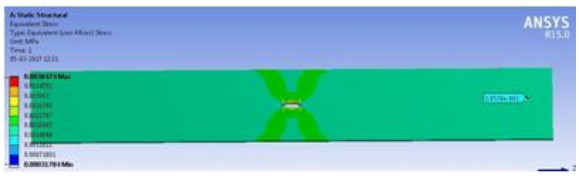

Fig 3.18 Central Inclined Notch of length 6 mm of angle 90

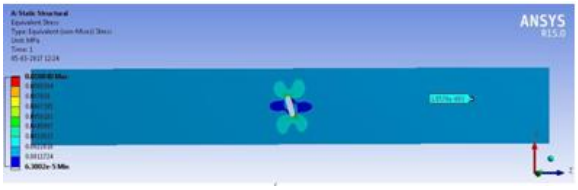

Fig 3.19 Central Inclined Notch of length 9 mm of angle 15

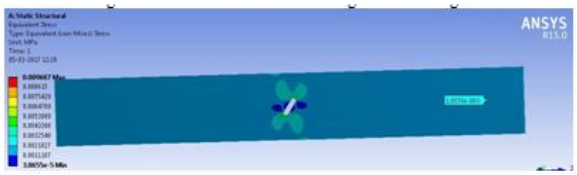

Fig 3.20 Central Inclined Notch of length 9 mm of angle 30

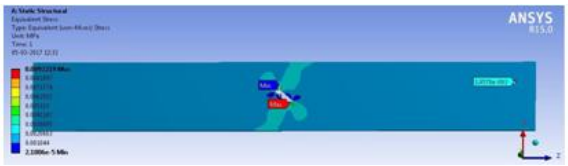

Fig 3.21 Central Inclined Notch of length 9 mm of angle 45

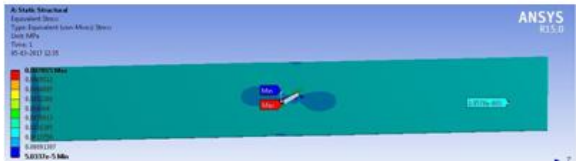

Fig 3.22 Central Inclined Notch of length 9 mm of angle 60

Fig 3.23 Central Inclined Notch of length 9 mm of angle 75

Fig 3.24 Central Inclined Notch of length 9 mm of angle 90

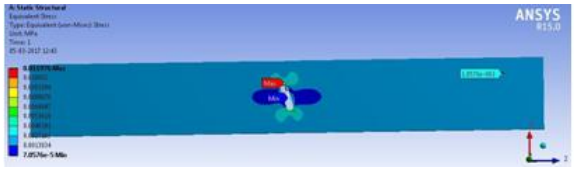

Fig 3.25 Central Inclined Notch of length 12 mm of angle 15

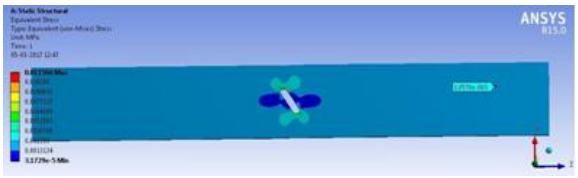

Fig 3.26 Central Inclined Notch of length 12 mm of angle 30

Fig 3.27Central Inclined Notch of length 12 mm of angle 45

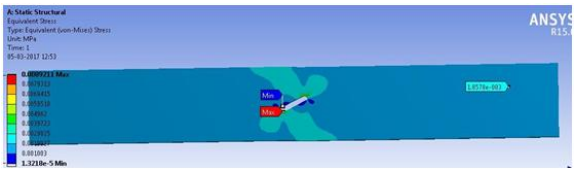

Fig 3.28 Central Inclined Notch of length 12 mm of angle 60

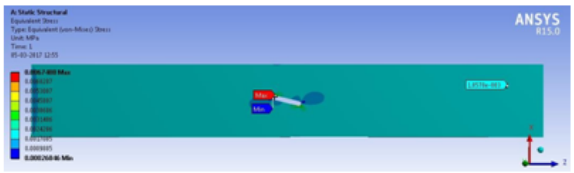

Fig 3.29 Central Inclined Notch of length 12 mm of angle 75

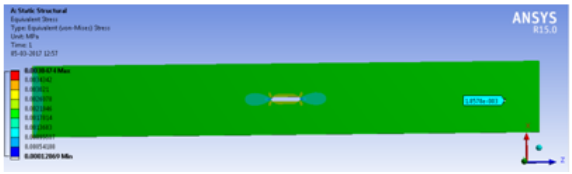

Fig 3.30 Central Inclined Notch of length 12 mm of angle 90

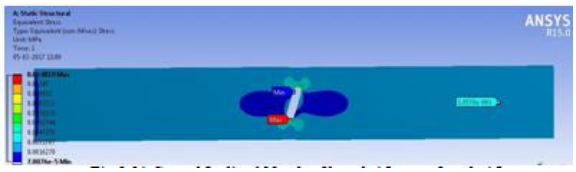

Fig 3.31 Central Inclined Notch of length 15 mm of angle 15

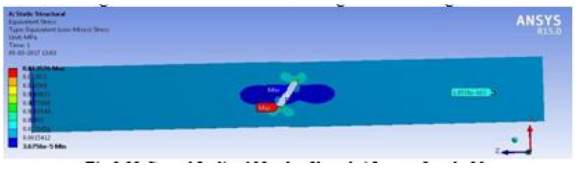

Fig 3.32 Central Inclined Notch of length 15 mm of angle 30

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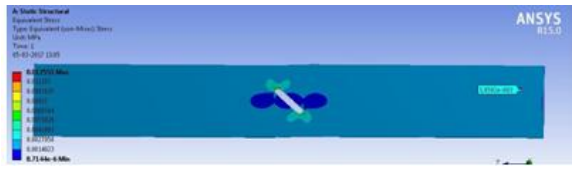


Fig 3.33 Central Inclined Notch of length 15 mm of angle 45

Fig 3.34 Central Inclined Notch of length 15 mm of angle 60

Fig 3.35 Central Inclined Notch of length 15 mm of angle 75

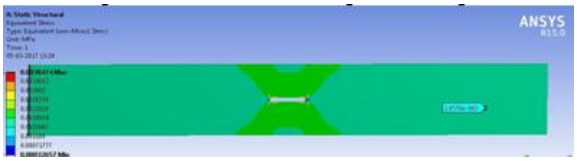


Fig 3.36 Central Inclined Notch of length 15 mm of angle 90

Stress concentration (Kt) = $maximum\ stress/nominal\ stress$

For Notch length 06 mm:

For specimen of notch length 06 with 15° = 0.0080318/1.857e-3 = 4.32

For specimen of notch length 06 with 30° = 0.006722/1.857e-3 = 3.62

For specimen of notch length 06 with 45° = 0.0077505/1.857e-3 = 4.17

For specimen of notch length 06 with 60° = 0.0067445/1.857e-3 = 3.630

For specimen of notch length 06 with 75° = 0.0056724/1.857e-3 = 3.053

For specimen of notch length 06 with 90° = 0.003847/1.857e-3 = 2.0707

For Notch length 09 mm:

For specimen of notch length 09 with 15° = 0.010048/1.857e-3 = 5.410

For specimen of notch length 09with 30° = 0.009687/1.857e-3 = 5.216

For specimen of notch length 09 with 45° = 0.0092219/1.857e-3 = 4.96 42

For specimen of notch length 09 with 60° = 0.007815/1.857e-3 = 4.208

For specimen of notch length 09 with 75° = 0.0061992/1.857e-3 = 3.338

For specimen of notch length 09 with 90° = 0.003847/1.857e-3 = 2.0707

For Notch length 12 mm:

For specimen of notch length 12 with 15° = 0.011976/1.857e-3 = 6.449

For specimen of notch length 12 with 30° = 0.011566/1.857e-3 = 6.228

For specimen of notch length 12 with 45° = 0.010733/1.857e-3 = 5.779

For specimen of notch length 12 with 60° = 0.0089211/1.857e-3 = 4.80

For specimen of notch length 12 with 75° = 0.0067488/1.857e-3 = 3.634

For specimen of notch length 12 with 90° = 0.003847/1.857e-3 = 2.0707

For Notch length 15 mm:

For specimen of notch length 15 with 15° = 0.014019/1.857e-3 = 7.549

For specimen of notch length 15 with 30° = 0.013576/1.857e-3 = 7.3107

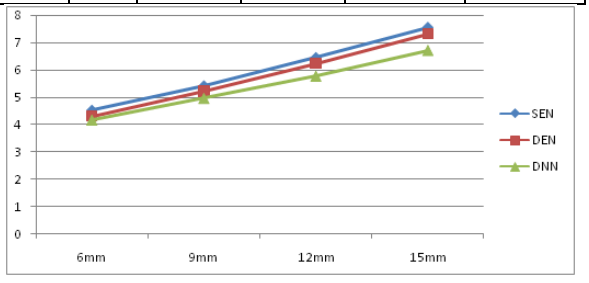
For specimen of notch length 15 with 45° = 0.012551/1.857e-3 = 6.751

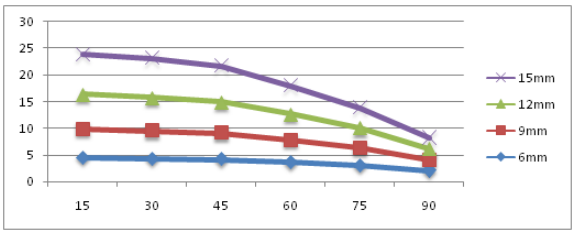
For specimen of notch length 15 with 60° = 0.009843/1.857e-3 = 5.300

For specimen of notch length 15 with 75° = 0.0073091/1.857e-3 = 3.935

For specimen of notch length 15 with 90° = 0.003847/1.857e-3 = 2.0707

CASE:		6mm	9mm	12mm	15mm
SEN		4.52	5.41	6.45	7.55
DEN		4.31	5.21	6.23	7.31
CNN		4.17	4.96	5.78	6.71
CIN	15	4.52	5.41	6.45	7.50
	30	4.31	5.21	6.23	7.31
	45	4.17	4.96	5.78	6.71
	60	3.63	4.20	4.80	5.30
	75	3.05	3.33	3.63	3.90
	90	2.07	2.07	2.07	2.07





4. Conclusions

By calculating Stress Concentration Factor for different specimens of different lengths & of different angles we came to conclude by comparing SEN and DEN. They are as the length of the notch increases Stress concentration factor increases. We have observed that SEN has more Stress Concentration Factor than DEN for that of same length. In all the cases the nominal stress is constant.

By comparing CIN of different angles we have observed that as the length increases the Stress Concentration Factor increases. As the angle increases the Stress Concentration Factor decreases. For all the specimens which is having angle 90 of different lengths have same Stress Concentration Factor.

We have observed in CNN as the notch length increase Stress Concentration Factor increases.

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Special thanks to many advisors (**V M MANOJ GUPTHA , M SINDHUJA**) who share their treasured notes with me. Oceans of gratitude for your caring communication I am over the moon with joy and so happy to share it with you.

Prof. MMM. SARCAR, have given me so many opportunities to challenge myself, and taught me that it is important to have my contribution recognized. I am the luckiest student ever to have had you as my mentor. i am missing you badly.

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