MATLAB Project (#2) - Metallic Failure Analysis

SE-160A Aerospace Structural Analysis, University of California, San Diego (Copyright J.B. Kosmatka, 2020)

Version: **Winter, 2020 (v1)**

Project Title: **Reader Example, Volume 1, page 151 (3.25), 3-D Principal Stresses**

Variable	Description	Value	Units
iInput	Input Units	1	1 = US, 2 = SI
iOutput	Output Units	1	1 = US, 2 = SI
ioption	Analysis Option	**1**	1 = Stress, 2 = Strain

	Units Reference	
	US	*SI*
σ, τ	10^3 lb/in^2	*MPa*
E, G	10^6 lb/in^2	*GPa*

Material Properties

Variable	Description	A-Basis	B-Basis	Units
E	Young's Modulus	**10.3**	**10.3**	Msi
G	Shear Modulus	**3.9**	**3.9**	Msi
σ_{yT}	Yield strength - tension	**68**	**70**	Ksi
σ_{uT}	Ultimate strength - tension	**78**	**80**	Ksi
σ_{yC}	Yield strength - compressio	**-70**	**-73**	Ksi
σ_{uC}	Uultimate strength - compr	**-78**	**-80**	Ksi
τ_y	Yield strength - shear	**35.25**	**35.25**	Ksi
τ_u	Ultimate strength - shear	**46**	**48**	Ksi

Safety Factors

Variable	Description	Value	Units
SF_y	Safety Factor - yield	**1.1**	1
SF_u	Safety Factor - ultimate	**1.5**	1

X **Option 1: Applied Stress State**

Applied Stress State

Variable	Description	Value	Units
σ_{xx}	Stress (σ_{xx})	**-7**	Ksi
σ_{yy}	Stress (σ_{yy})	**1**	Ksi
σ_{zz}	Stress (σ_{zz})	**0.5**	Ksi
τ_{yz}	Stress (τ_{yz})	**0**	Ksi
τ_{xz}	Stress (τ_{xz})	**0**	Ksi
τ_{xy}	Stress (τ_{xy})	**3**	Ksi

X **Option 2: Measured Strain State From Rosettes**

Strain Gage Rosette

Variable	Description	Value	Units
θ_A	Orientation Angle (A)		degree
θ_B	Orientation Angle (B)		degree
θ_C	Orientation Angle (C)		degree
θ	Gage Rotation Angle		degree

Measured Strains

Variable	Description	Value	Units
ε_A	Strain (A)		μ in/in
ε_B	Strain (B)		μ in/in
ε_C	Strain (C)		μ in/in

0 **END OF FILE**

MATLAB Project (#2) - Metallic Failure Stress Analysis

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Version: Winter, 2020 (v2) - Input: US, Output: US/SI

Student Name: John Kosmatka
Student ID: A0123456789

Project Title: Reader Example, Volume 1, page 151 (3.25), 3-D Principal Stresses

INPUT ECHO:

Variable	Description	Value	Units
iInput	Input Units	1	1 = US, 2 = SI
iOutput	Output Units	1	1 = US, 2 = SI
Ioption	Analysis Option	1	1 = Stress, 2 = Strain

	Units Reference	
	US	*SI*
σ, τ	10^3 lb/in^2	*MPa*
E, G	10^6 lb/in^2	*GPa*

Material Properties

Variable	Description	A-Basis	B-Basis	Units
E	Young's Modulus	10.3000	10.3000	Msi
G	Shear Modulus	3.9000	3.9000	Msi
σ_{yT}	yield strength - tension	68.0000	70.0000	Ksi
σ_{uT}	ultimate strength - tension	78.0000	80.0000	Ksi
σ_{yC}	yield strength - compressior	-70.0000	-73.0000	Ksi
σ_{uC}	ultimate strength - compres	-78.0000	-80.0000	Ksi
τ_y	yield strength - shear	35.2500	35.2500	Ksi
τ_u	ultimate strength - shear	46.0000	48.0000	Ksi

Safety Factors

Variable	Description	Value	Units
SF_y	Safety Factor - yield	1.1	1
SF_u	Safety Factor - ultimate	1.5	1

Applied Stress State

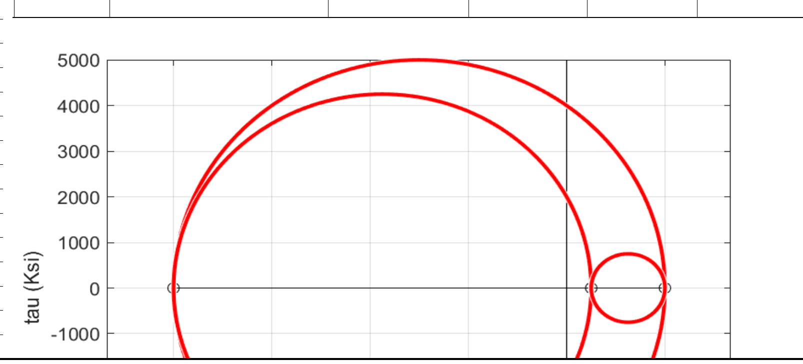
Variable	Description	Value	Units
σ_{xx}	Normal Stress - x	-7.0000	Ksi
σ_{yy}	Normal Stress - y	1.0000	Ksi
σ_{zz}	Normal Stress - z	0.5000	Ksi
τ_{yz}	Shear Stress - yz	0.0000	Ksi
τ_{xz}	Shear Stress - xz	0.0000	Ksi
τ_{xy}	Shear Stress - xy	3.0000	Ksi

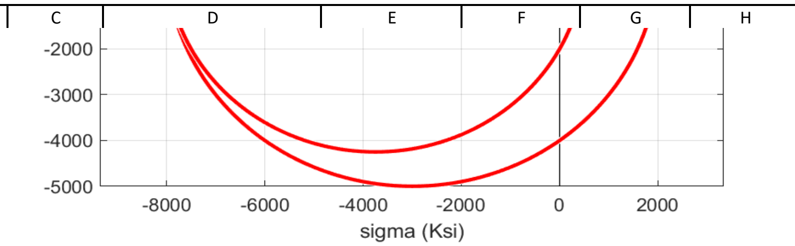
OUTPUT:

1.) Principal Stress State

Variable	Description	1	2	3	Units
σ_p	Principal Stresses	-8.0000	0.5000	2.0000	Ksi
		-0.9487	0.0000	-0.3162	1
$\{\Phi\}$	Eigenvector {Q}	0.3162	0.0000	-0.9487	1
		0.0000	1.0000	0.0000	1

Variable	Description	Value	Units
τ_{max}	Maximum Shear Stress	5.0000	Ksi





2.) Allowable Strengths

Variable	Description	A-Basis	B-Basis	Units
σ_T*	Allowable Tension	52.0000	53.3333	Ksi
σ_C*	Allowable Compression	-52.0000	-53.3333	Ksi
τ*	Allowable Shear	30.6667	32.0000	Ksi
τ*	Allow Shear Tresca (Mixed)	26.0000	26.6667	Ksi

3.) Margin of Safety (MS)

Minimum Margin of Safety		Rankine	Tresca*	Von Mises
MS_{min} (A)	Min Margin of Safety (A Basi	5.5000	4.2000	4.5670
MS_{min} (B)	Min Margin of Safety (B Basi	5.6667	4.3333	4.7097

Applied Stress State for (MS=0) - A Basis

Variable	Description	Rankine	Tresca*	Von Mises	Units
σ_{xx}	Normal Stress - x	-45.5000	-36.4000	-38.9689	Ksi
σ_{yy}	Normal Stress - y	6.5000	5.2000	5.5670	Ksi
σ_{zz}	Normal Stress - z	3.2500	2.6000	2.7835	Ksi
τ_{yz}	Shear Stress - yz	0.0000	0.0000	0.0000	Ksi
τ_{xz}	Shear Stress - xz	0.0000	0.0000	0.0000	Ksi
τ_{xy}	Shear Stress - xy	19.5000	15.6000	16.7010	Ksi

Applied Stress State for (MS=0) - B Basis

Variable	Description	Rankine	Tresca*	Von Mises	Units
σ_{xx}	Normal Stress - x	-46.6667	-37.3333	-39.9682	Ksi
σ_{yy}	Normal Stress - y	6.6667	5.3333	5.7097	Ksi
σ_{zz}	Normal Stress - z	3.3333	2.6667	2.8549	Ksi
τ_{yz}	Shear Stress - yz	0.0000	0.0000	0.0000	Ksi
τ_{xz}	Shear Stress - xz	0.0000	0.0000	0.0000	Ksi
τ_{xy}	Shear Stress - xy	20.0000	16.0000	17.1292	Ksi

*** Note: For the Tresca Criteria; the Margin of Safety calculations depend upon the stress state:**

for pure <u>tension</u>, MS is the minimum of the tension (σ_T*) criteria, shear (τ*) criteria, and shear (σ_T*/2) criteria

for <u>pure compression</u>, MS is the minimum of the compression (σ_C*) criteria, shear (τ*) criteria, and shear (|σ_C*|/2)

for <u>mixed stress</u>, MS is the minimum of tension (σ_T*), compression (σ_C*), shear (τ*), and shear ((σ_T*-σ_C*)/4) criteria

End of Output