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 155 (3.29), 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})	**20**	Ksi
σ_{yy}	Stress (σ_{yy})	**40**	Ksi
σ_{zz}	Stress (σ_{zz})	**-20**	Ksi
τ_{yz}	Stress (τ_{yz})	**20**	Ksi
τ_{xz}	Stress (τ_{xz})	**-60**	Ksi
τ_{xy}	Stress (τ_{xy})	**-40**	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

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Student ID: A0123456789

Project Title: Reader Example, Volume 1, page 155 (3.29), 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 - compressio	-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

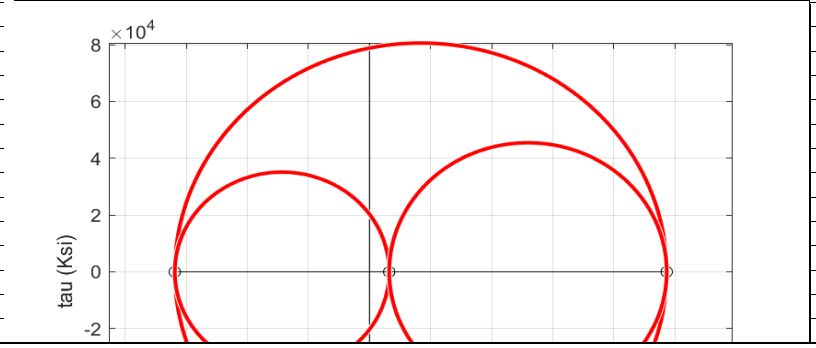
Variable	Description	Value	Units
σ_{xx}	Normal Stress - x	20.0000	Ksi
σ_{yy}	Normal Stress - y	40.0000	Ksi
σ_{zz}	Normal Stress - z	-20.0000	Ksi
τ_{yz}	Shear Stress - yz	20.0000	Ksi
τ_{xz}	Shear Stress - xz	-60.0000	Ksi
τ_{xy}	Shear Stress - xy	-40.0000	Ksi

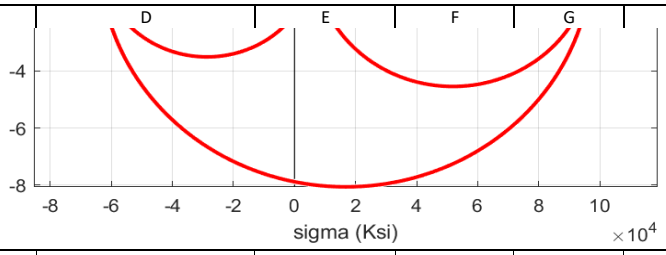
OUTPUT:

1.) Principal Stress State

Variable	Description	1	2	3	Units
σ_p	Principal Stresses	-63.8255	6.4350	97.3905	Ksi
		-0.6053	0.4488	-0.6574	1
$\{\Phi\}$	Eigenvector {Q}	-0.0807	0.7870	0.6116	1
		-0.7919	-0.4232	0.4402	1

Variable	Description	Value	Units
τ_{max}	Maximum Shear Stress	80.6080	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 Bas	-0.4661	-0.6775	-0.6286
MS_{min} (B)	Min Margin of Safety (B Bas	-0.4524	-0.6692	-0.6190

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

Variable	Description	Rankine	Tresca*	Von Mises	Units
σ_{xx}	Normal Stress - x	10.6787	6.4510	7.4286	Ksi
σ_{yy}	Normal Stress - y	21.3573	12.9020	14.8571	Ksi
σ_{zz}	Normal Stress - z	-10.6787	-6.4510	-7.4286	Ksi
τ_{yz}	Shear Stress - yz	10.6787	6.4510	7.4286	Ksi
τ_{xz}	Shear Stress - xz	-32.0360	-19.3529	-22.2857	Ksi
τ_{xy}	Shear Stress - xy	-21.3573	-12.9020	-14.8571	Ksi

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

Variable	Description	Rankine	Tresca*	Von Mises	Units
σ_{xx}	Normal Stress - x	10.9525	6.6164	7.6190	Ksi
σ_{yy}	Normal Stress - y	21.9050	13.2328	15.2381	Ksi
σ_{zz}	Normal Stress - z	-10.9525	-6.6164	-7.6190	Ksi
τ_{yz}	Shear Stress - yz	10.9525	6.6164	7.6190	Ksi
τ_{xz}	Shear Stress - xz	-32.8574	-19.8492	-22.8571	Ksi
τ_{xy}	Shear Stress - xy	-21.9050	-13.2328	-15.2381	Ksi

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

for pure tension, MS is the minimum of the tension (σ_T^*) criteria, shear (τ^*) criteria, and shear ($\sigma_T^*/2$) criteria

for pure compression, MS is the minimum of the compression (σ_C^*) criteria, shear (τ^*) criteria, and shear ($|\sigma_C^*|/2$)

for mixed stress, MS is the minimum of tension (σ_T^*), compression (σ_C^*), shear (τ^*), and shear ($(\sigma_T^*-\sigma_C^*)/4$) criteria

End of Output