

The Stress Invariant Simulator (SISi)

Dr. André Haufe

An engineering toy to visualize stress invariants

(downloadable from the www.dynamore.de)

Crafting instructions

- Download the PDF-file (this file!)
- Print crafting sections on thick piece of paper
- Cut out where indicated
- Add four wooden sticks (approx. 15cm of length)
- Add some glue where necessary
(engineers should find out the locations without further instructions from the pictures – all others contact their local distributor please)
- Have fun!



page 1:

This page contains the first part of the Stress Invariant Simulator (SISi). It features a large diagram of a tetrahedron representing stress space, with faces labeled $\sigma_I = 0$, $\sigma_{II} = 0$, and $\sigma_{III} = 0$. A note says "Attach von Mises cylinder here!". To the right are three circular cutouts labeled σ_I , σ_{II} , and σ_{III} , each with a pair of scissors icon. Below the tetrahedron is a circle divided into three sectors: red (top), yellow (bottom-left), and green (bottom-right). A note next to it says "von Mises compression shear tension". A purple circle is shown below the main diagram. To the right is a vertical column of mathematical definitions and coordinate systems.

Stress Invariant Simulator (SISi)

Definition of stress invariants

$$I_1 = \sigma_I + \sigma_{II} + \sigma_{III} = \sigma_n = -3p = 3\sigma_m$$
$$J_2 = \frac{1}{2} s_y s_{yz} \quad \text{where} \quad s_y = \sigma_y - \frac{I_1}{3} \delta_y$$
$$\sigma_{vM} = \sqrt{3 J_2}$$
$$\eta = \frac{\sigma_m}{\sigma_{vM}} = -\frac{p}{\sigma_{vM}} = \frac{I_1}{3\sigma_{vM}}$$
$$\xi = \frac{2\pi}{2} \frac{J_3}{\sigma_{vM}^3} \quad \text{where} \quad J_3 = \det \mathbf{s}$$

Haigh-Westergaard-coordinates

A 2D plot in the Haigh-Westergaard coordinate system. The vertical axis is σ_{III} and the horizontal axis is σ_{II} . A point P is shown in the first quadrant. A line segment connects the origin O to P . The angle between this line and the σ_{III} -axis is θ . A perpendicular line from P to the σ_{III} -axis is labeled σ_I . The distance from the origin to P is labeled σ_{vM} . The text "© by DYNAmore GmbH" is at the bottom right.

DYNAmore Stress Invariant Simulator (SISi)

DYNAmore Stress Invariant Simulator – A. Haufe

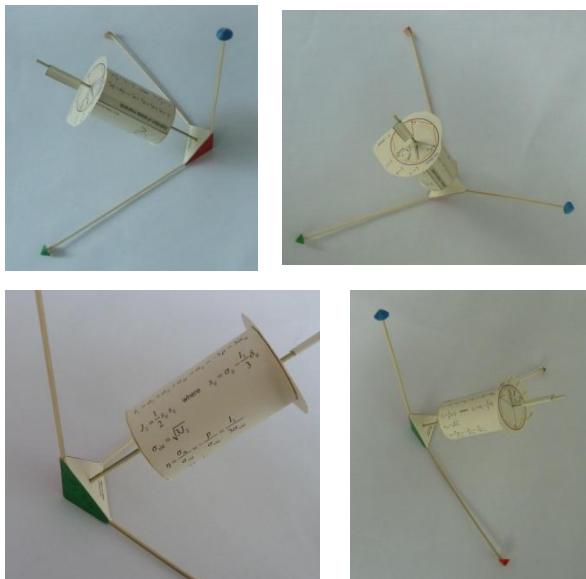
An engineering toy to visualize stress invariants

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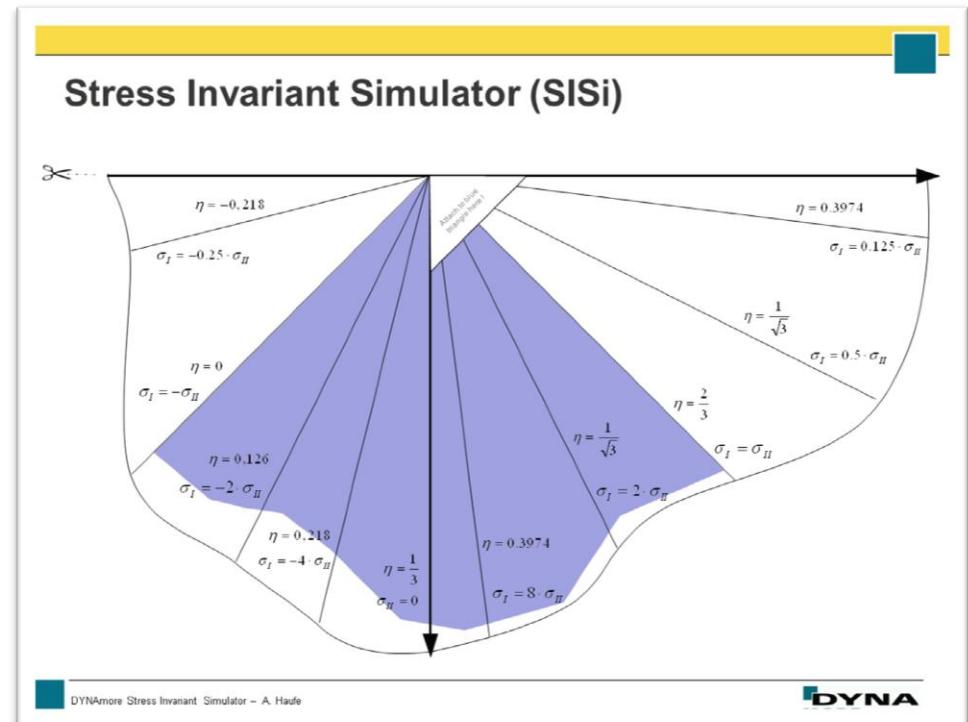
Crafting instructions

- Page 2 of the set may be added for further clarification of the triaxiality variable.

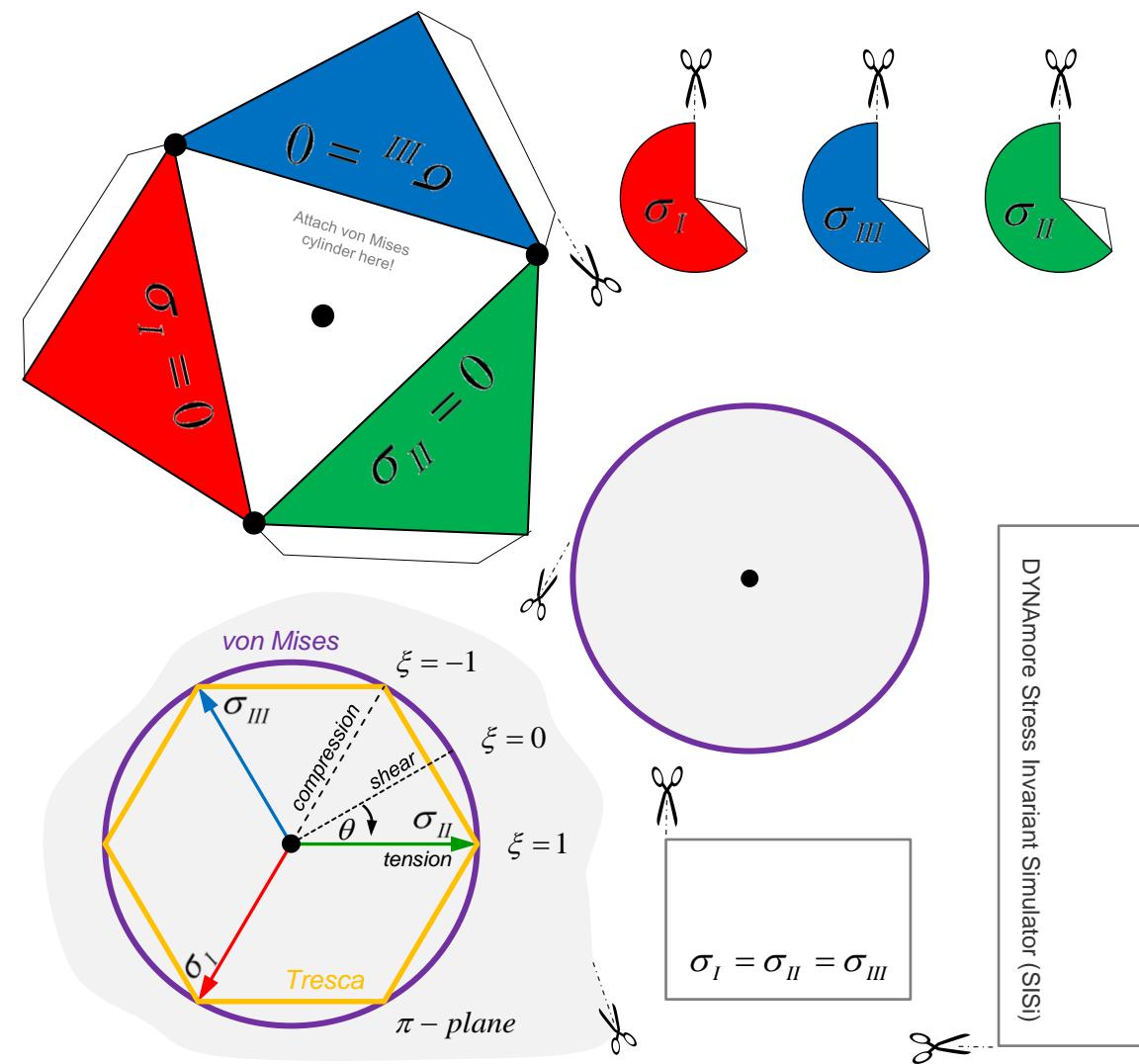
Final shape of toy



page 2:



Stress Invariant Simulator (SISi)



DYNAMore Stress Invariant Simulator (SISi)

Definition of stress invariants

$$I_1 = \sigma_I + \sigma_{II} + \sigma_{III} = \sigma_{ii} = -3p = 3\sigma_m$$

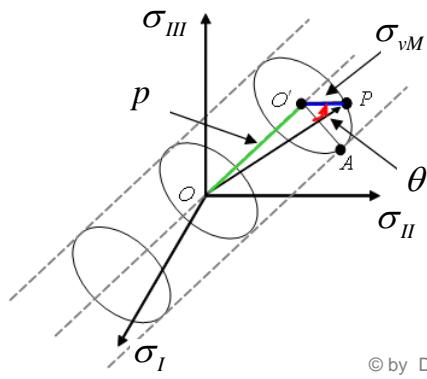
$$J_2 = \frac{1}{2} s_{ij} s_{ij} \quad \text{where} \quad s_{ij} = \sigma_{ij} - \frac{I_1}{3} \delta_{ij}$$

$$\sigma_{vM} = \sqrt{3J_2}$$

$$\eta = \frac{\sigma_m}{\sigma_{vM}} = -\frac{p}{\sigma_{vM}} = \frac{I_1}{3\sigma_{vM}}$$

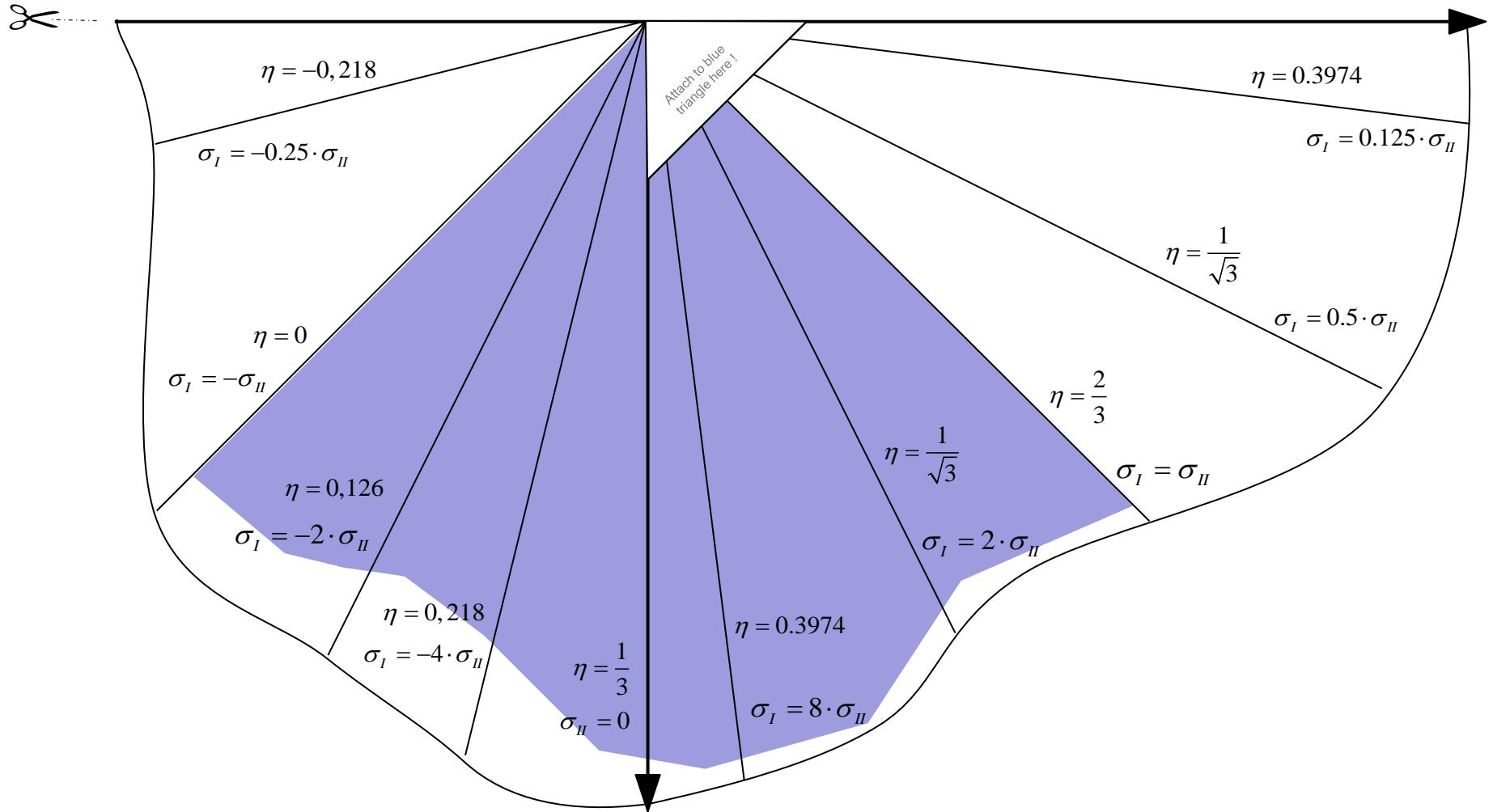
$$\xi = \frac{27}{2} \frac{J_3}{\sigma_{vM}^3} \quad \text{where} \quad J_3 = \det \mathbf{s}$$

Haigh-Westergaard-coordinates



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Stress Invariant Simulator (SISi)





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