3D plasticity

REFERENCE	Background to Material Non-Linear Benchmarks, Ref . R0049, NAFEMS, Glasgow, 1998
MODEL FILENAME	3D Plasticity.nfx

Figure 1 shows a 3D cube model undergoing elastic-plastic deformation. Two plasticity models are considered; a perfect plasticity and an isotropic hardening model. The boundary condition is depicted in Figure 1 and the loading condition is summarized in Table 1. 3D continuum elements are utilized to obtain nonlinear responses.

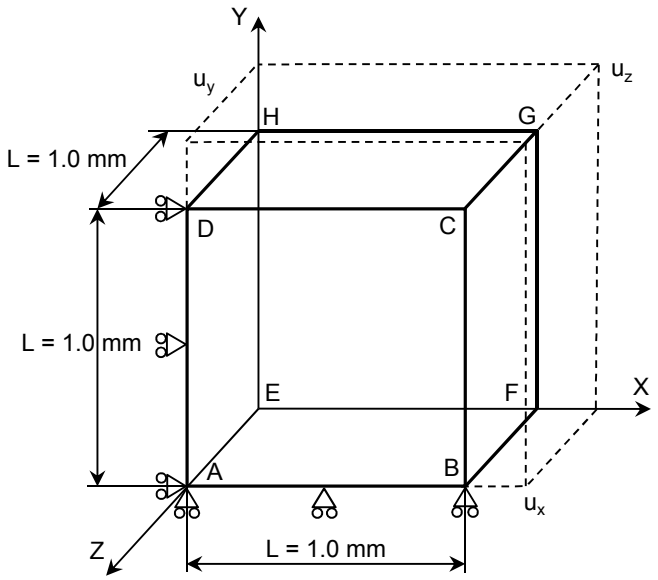
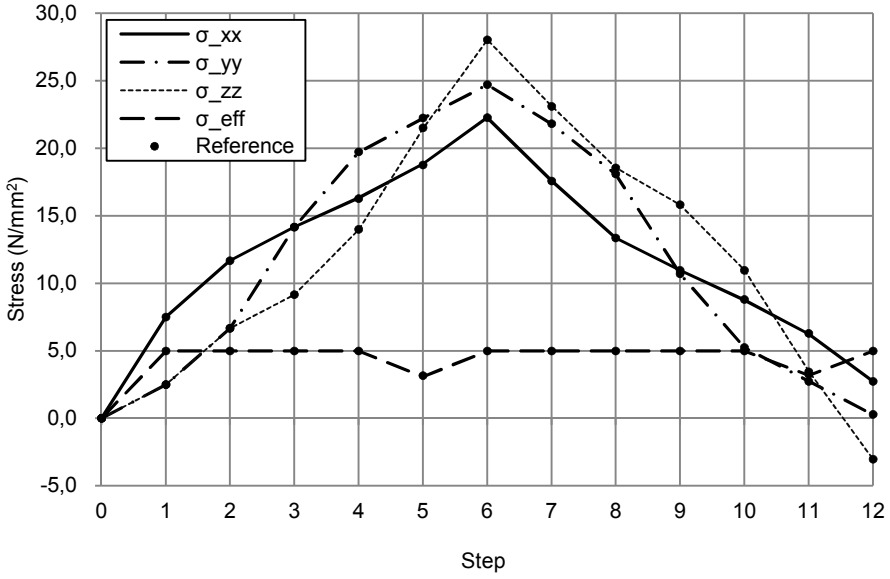
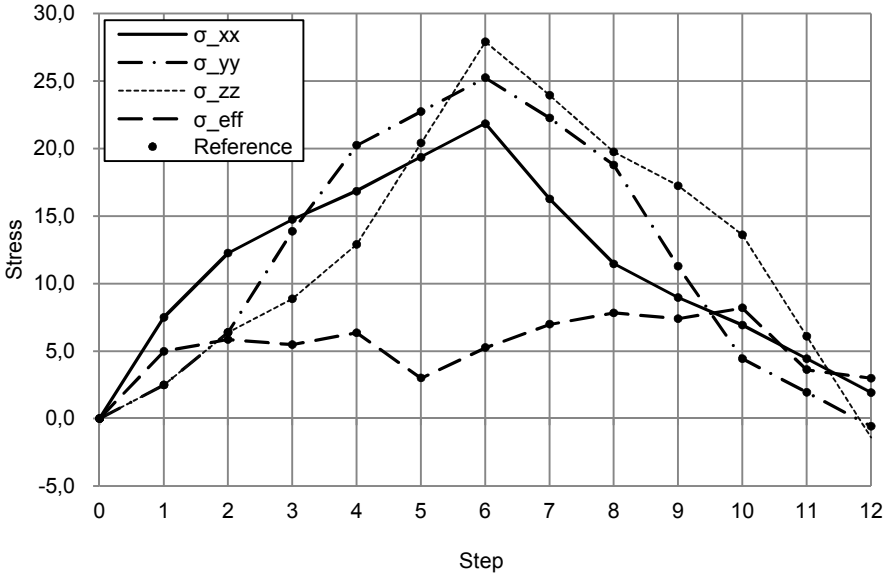


Figure 1. 3D solid model

Material data	Young's modulus	$E = 250.0 \times 10^3\ N/mm^2$
	Poisson's ratio	$\nu = 0.25$
	Perfect plasticity	$\sigma_Y = 5.0\ N/mm^2$
	Isotropic hardening	$E_T = 50.0 \times 10^3\ N/mm^2$

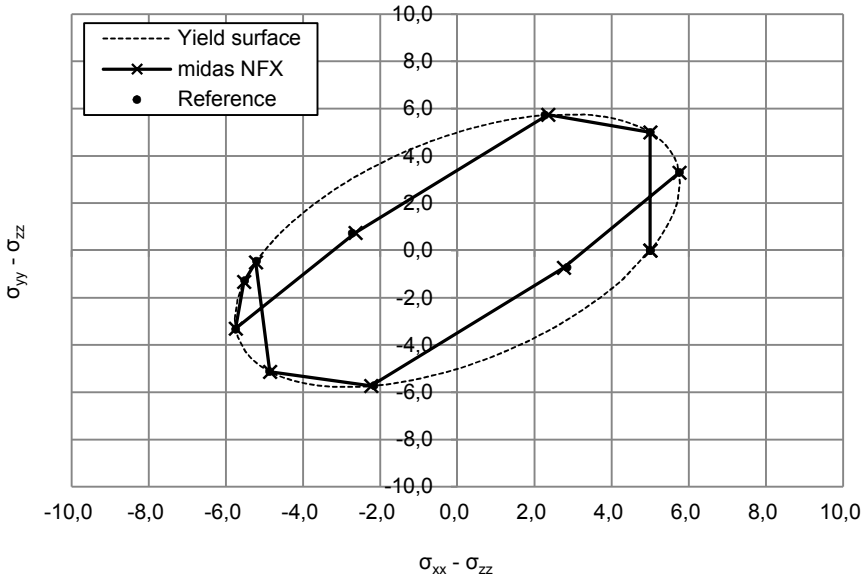


(a) Perfect plasticity

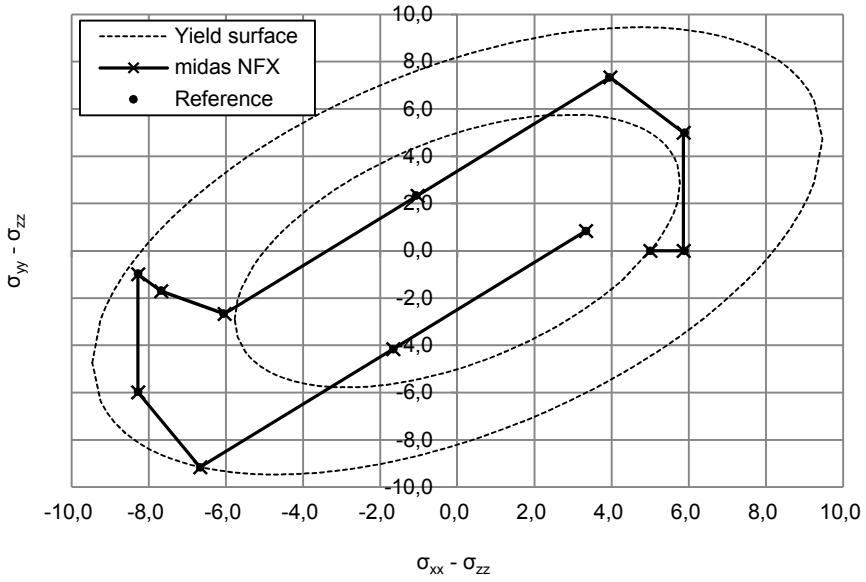


(b) Isotropic hardening

Figure 2. Stress variation obtained using solid elements



(a) Perfect plasticity



(b) Isotropic hardening

Figure 3. Stress path obtained using solid elements

Table 1. Displacements prescribed in 12 increments ($R = 2.5 \times 10^{-5}$)

Step	Disp. change	δ_x [mm]	δ_y [mm]	δ_z [mm]
Step 1	$\Delta u_x = R$	R	0.0	0.0
Step 2	$\Delta u_x = R$	2R	0.0	0.0
Step 3	$\Delta u_y = R$	2R	R	0.0
Step 4	$\Delta u_y = R$	2R	2R	0.0
Step 5	$\Delta u_z = R$	2R	2R	R
Step 6	$\Delta u_z = R$	2R	2R	2R
Step 7	$\Delta u_x = -R$	R	2R	2R
Step 8	$\Delta u_x = -R$	0.0	2R	2R
Step 9	$\Delta u_y = -R$	0.0	R	2R
Step 10	$\Delta u_y = -R$	0.0	0.0	2R
Step 11	$\Delta u_z = -R$	0.0	0.0	R
Step 12	$\Delta u_z = -R$	0.0	0.0	0.0

Table 2. Stress obtained at of step 6, perfect plasticity

	No. of elements	σ_{xx} [N/mm²]	σ_{yy} [N/mm²]	σ_{zz} [N/mm²]	σ_{eff} [N/mm²]
Reference		**22.27493**	**24.70006**	**28.02500**	**5.000002**
HEXA-8	1	**22.26845**	**24.71130**	**28.02025**	**5.000000**

Table 3. Stress obtained at step 6, isotropic hardening

	No. of elements	σ_{xx} [N/mm²]	σ_{yy} [N/mm²]	σ_{zz} [N/mm²]	σ_{eff} [N/mm²]
Reference		**21.84202**	**25.24927**	**27.90871**	**5.267201**
HEXA-8	1	**21.86400**	**25.23665**	**27.89935**	**5.238801**