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Ansys10

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$\theta_2$

$\theta_1$

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ASTM – E8M

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St37

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ASTM-E8M

G

E

$$E_2 = E_3$$

$$G_{12} = G_{13}$$

$E_2$

$E_1$

$E_3$

/

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/

$$G_{12} = \frac{E_0 E_{45}}{E_0 \left(1 - \frac{E_{45}}{4E_{90}}\right) + E_{45} \left(\frac{\nu}{2} - \frac{1}{4}\right)}$$

$$G_{23} = \frac{E}{2(1 + \nu)}$$

$r_\alpha$

$\alpha$

( )

$$r_\alpha = \frac{\varepsilon_w^\rho}{\varepsilon_t^\rho}$$

)

$\varepsilon_t^P$   $\varepsilon_w^P$

(

$\alpha$

...

$$\varepsilon_{ii}^p = 0 \rightarrow \varepsilon_3^p = -(\varepsilon_1^p + \varepsilon_2^p) \rightarrow r_\alpha = \frac{-\varepsilon_2^p}{\varepsilon_1^p + \varepsilon_2^p} \quad ( )$$

ASTM:E-517-81 ( )  $\varepsilon_w^p, \varepsilon_1^p$

( )

$$r = \frac{r_0 + 2r_{45} + r_{90}}{4} \quad ( )$$

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Solid185

xy

z

y

x

$$(G+H)\sigma_x^2 - 2H\sigma_x\sigma_y + (H+F)\sigma_y^2 + 2N\tau_{xy}^2 = 1 \quad ( )$$

N, M, L, H, G, F

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Canta174

Targe170

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Al6061

Al6061

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: G

: r

: v

:  $\epsilon_w^p$

:  $\epsilon_t^p$

:  $r_\alpha$

:  $\theta$

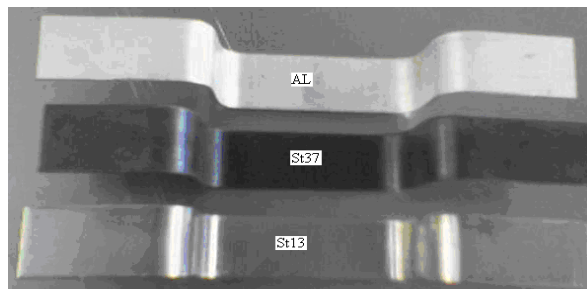
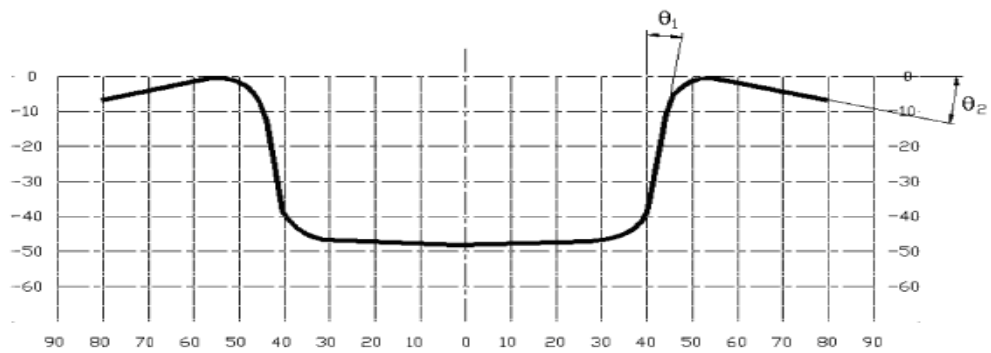
Al6061(90 deg), t = 2 mm, F = 5 KN

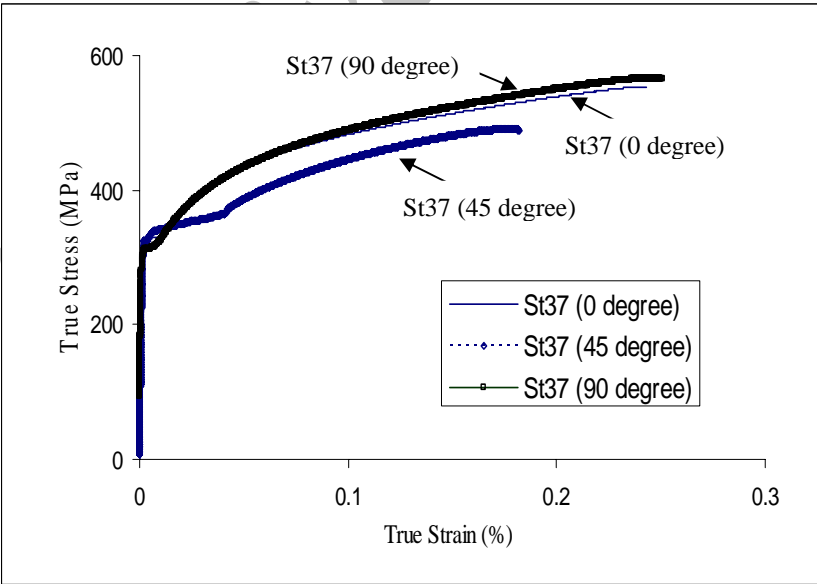
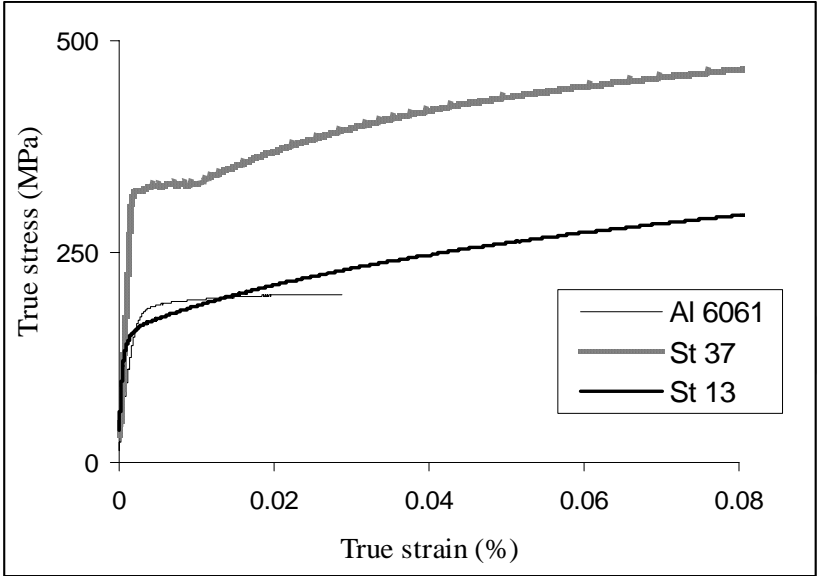
	<b>Experiment</b>	<b>Isotropic hardening</b>	<b>Kinematic hardening</b>
$\theta_1$ (°)	/	/	/
$\theta_2$ (°)	/	/	/

Al6061(90 deg), t = 2 mm, F = 3.5KN

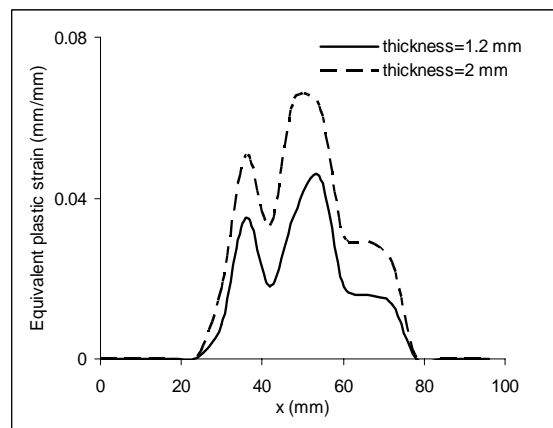
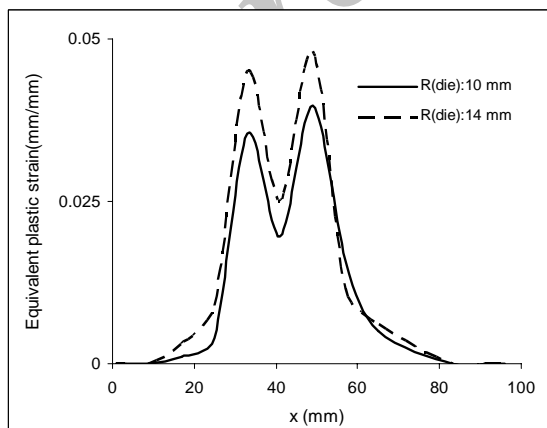
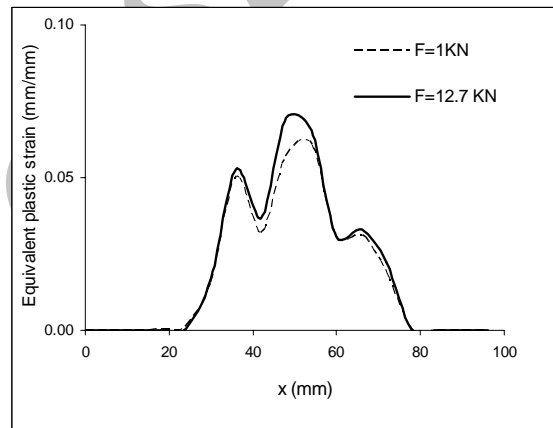
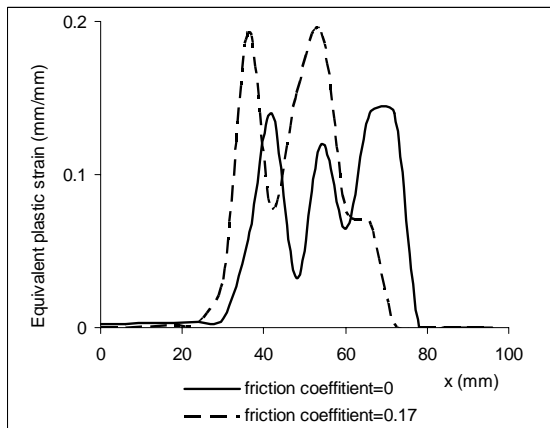
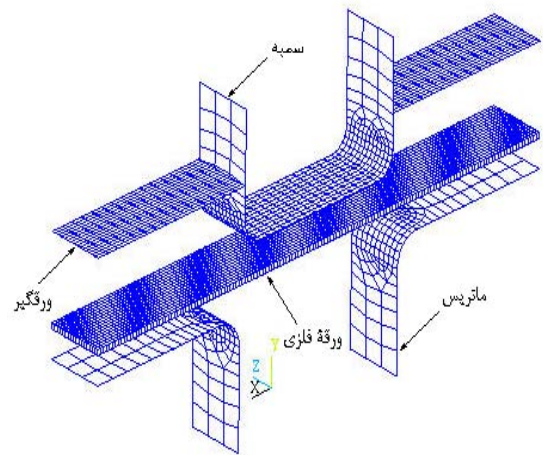
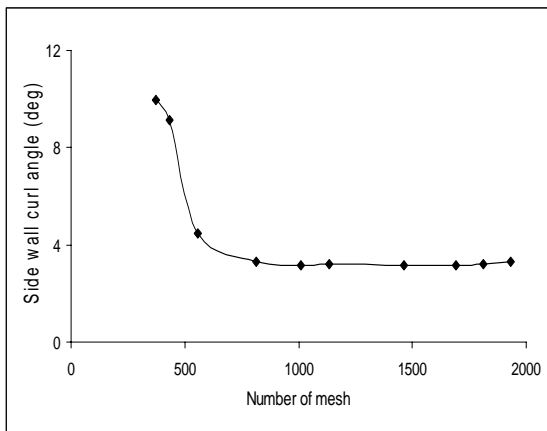
	<b>Experiment</b>	<b>Isotropic hardening</b>	<b>Kinematic hardening</b>
$\theta_1$ (°)	/	/	/
$\theta_2$ (°)	/	/	/

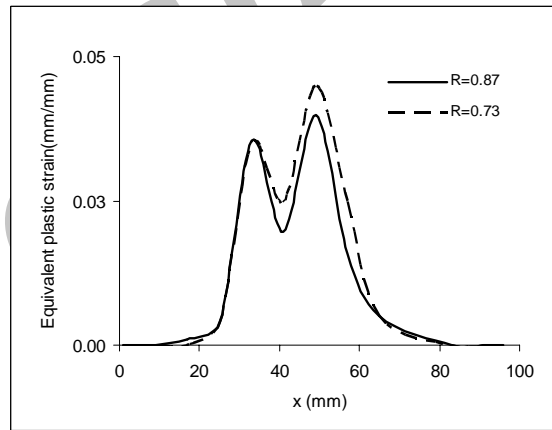
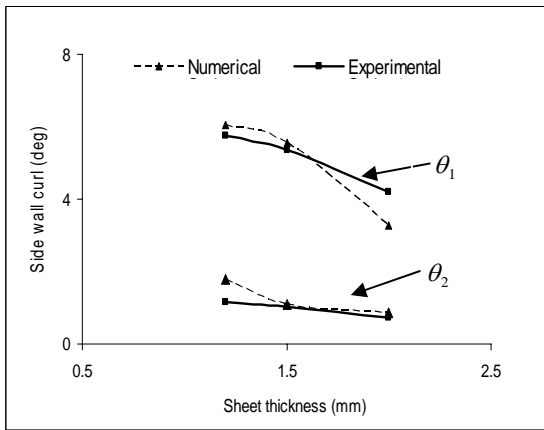
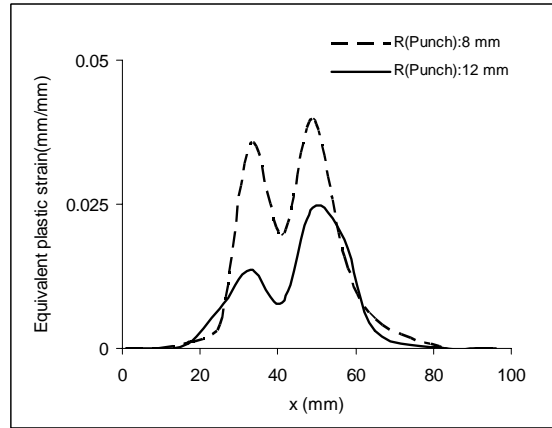
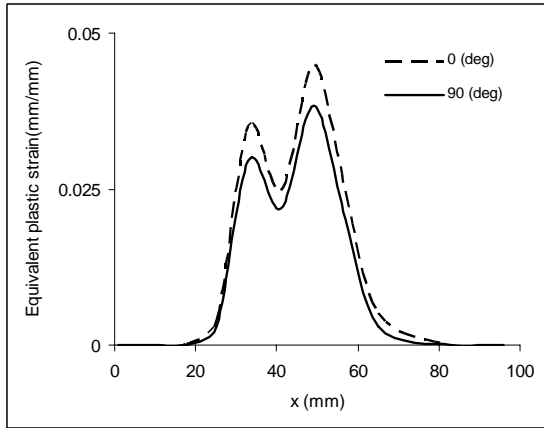
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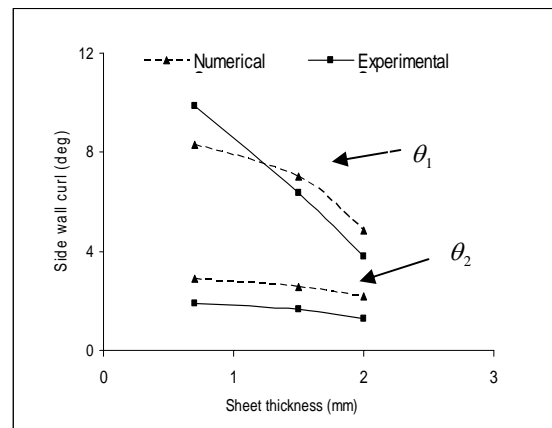
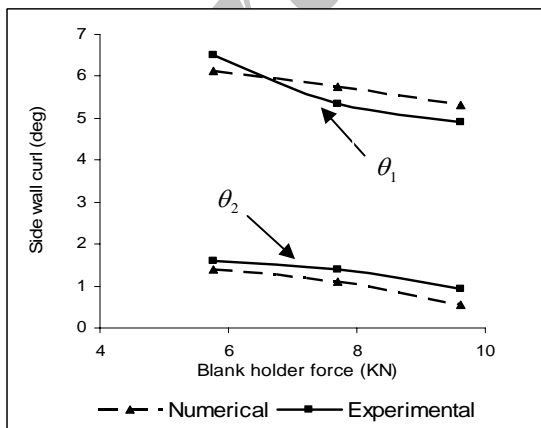


St37





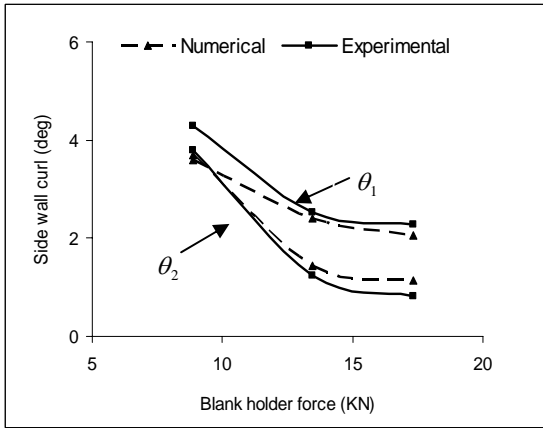
St13



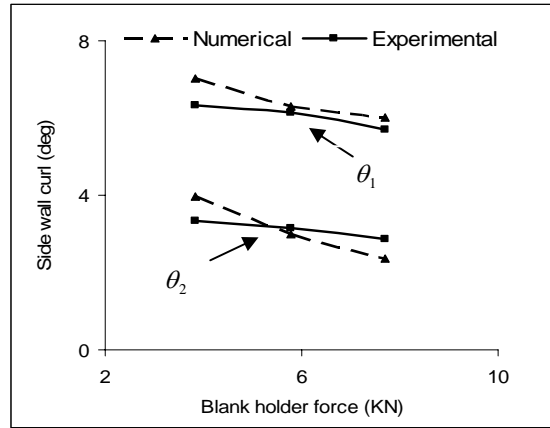
Al6061

Al6061

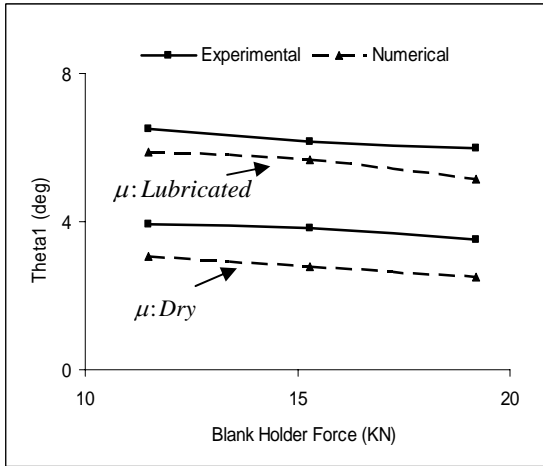




St37

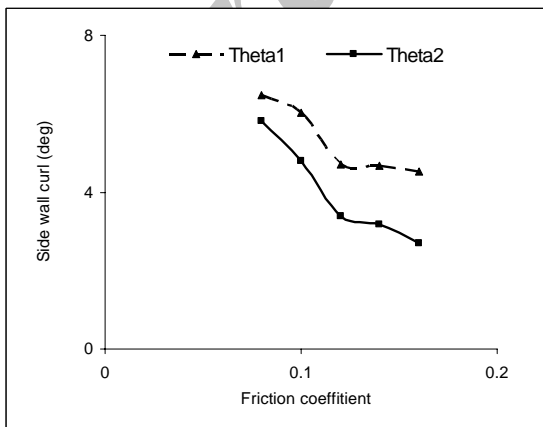
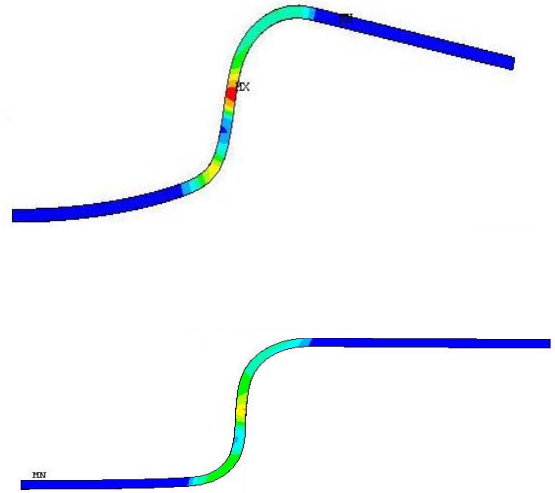


St13

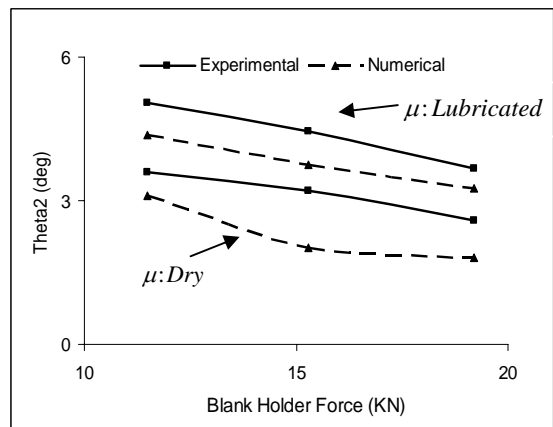


St37

$\theta_1$

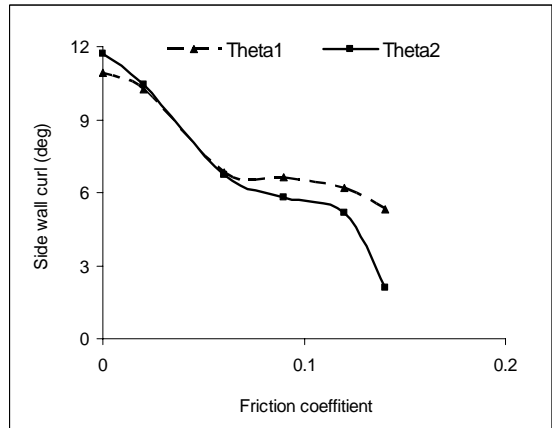
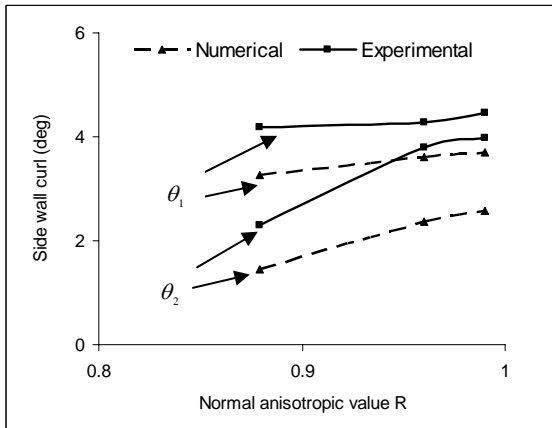


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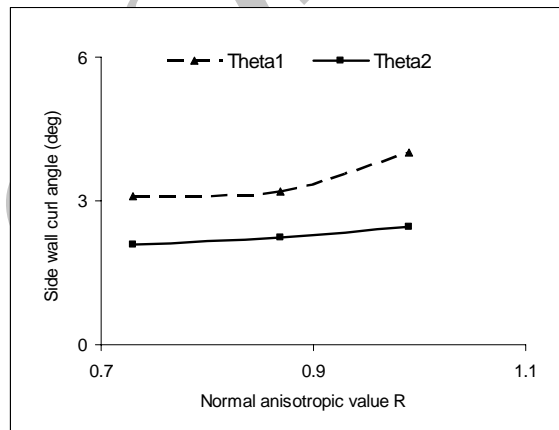
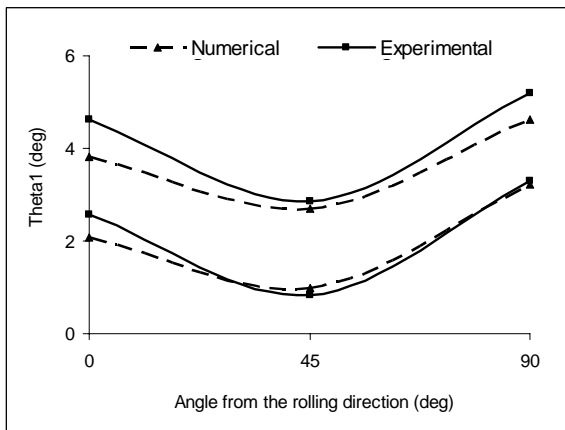


St37

$\theta_2$



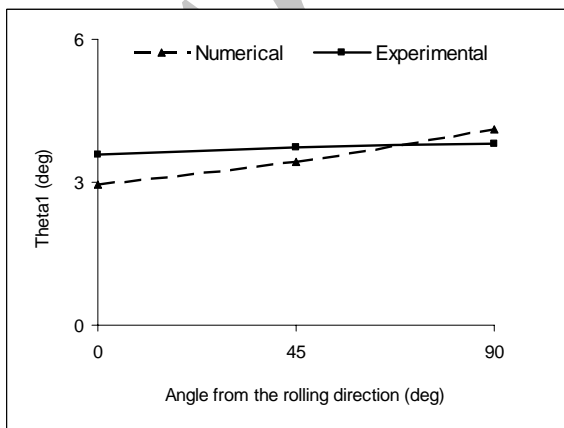
A16061



A16061

$\theta_1$

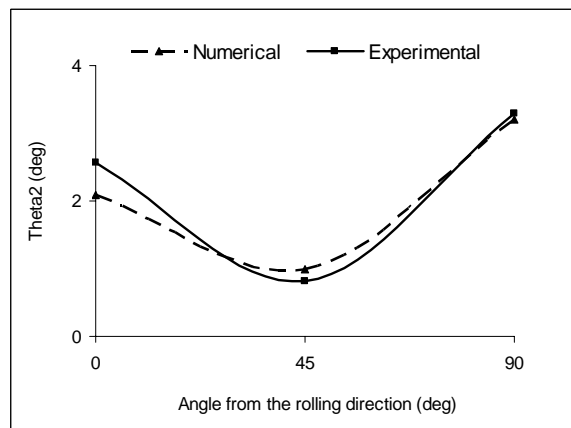
(Blank holder force=5 KN)



A16061

$\theta_1$

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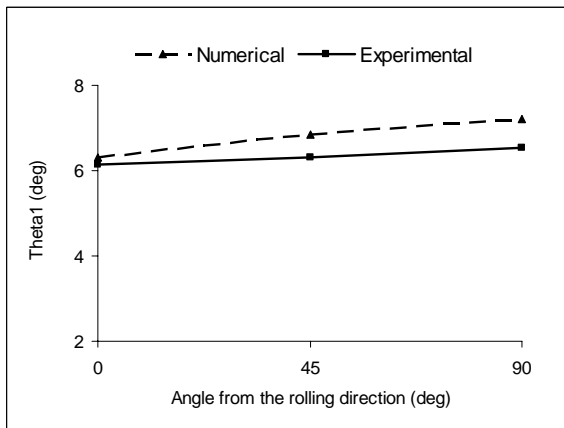


A16061

$\theta_2$

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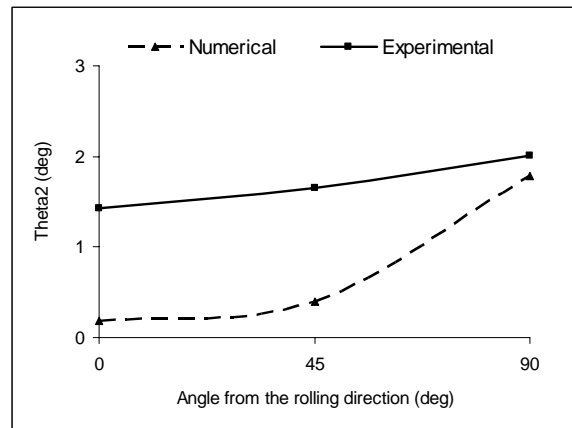
(Blank holder force = 5 KN)



St13

$\theta_1$

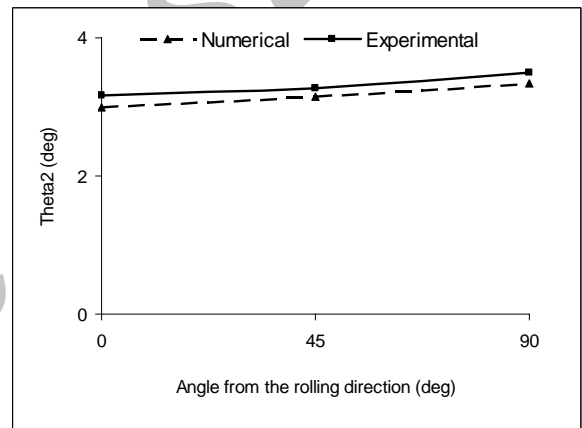
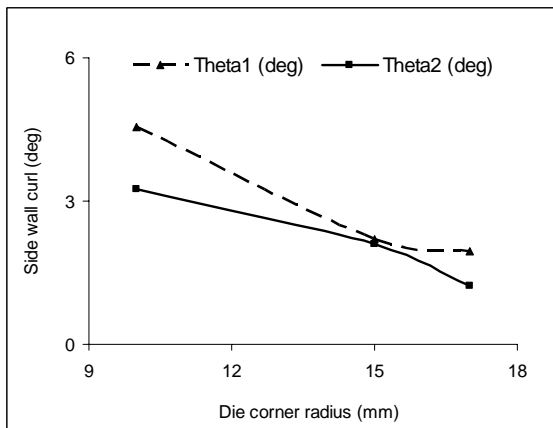
(Blank holder force = 12 KN)



Al6061

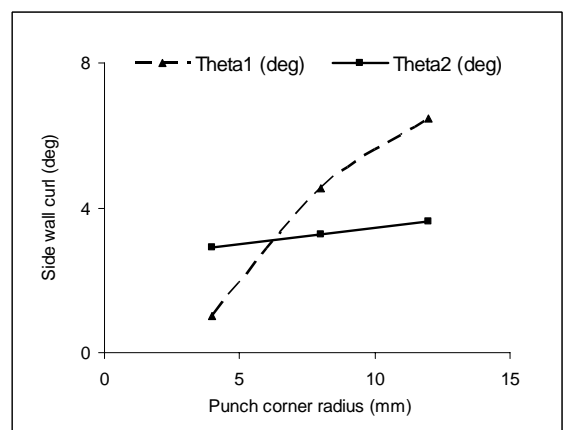
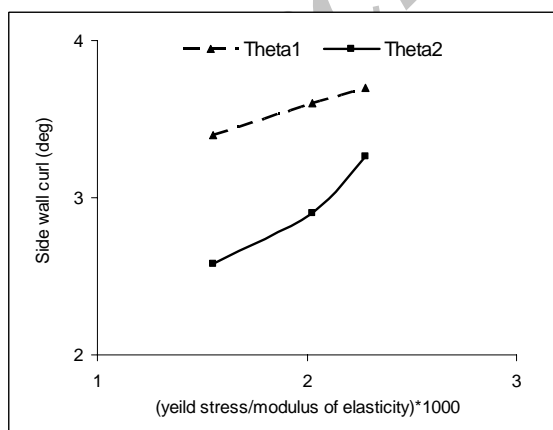
$\theta_2$

(Blank holder force = 12 KN)



St13

$\theta_2$



$\sigma_y / E$

## **Abstract**

Sheet metal forming may frequently produce the unacceptable products with wrinkle, tear, poor dimension precision, and so on, unless tool and process parameters are appropriately chosen. In particular, the dimension precision becomes a major concern in sheet metal bending process owing to considerable elastic recovery during unloading which leads to springback and side wall curl. In this study, the U-draw bending process on three different Aluminum & Steel alloys which are widely used in the industry especially in the automobile and aircraft industries, is investigated experimentally and numerically to consider the effect of anisotropy, sheet thickness, blank holder force, friction coefficient and sheet material on the springback and side wall curl. To study the effect of anisotropy and thickness of sheets experimentally, sheets are prepared in three thicknesses and cut out in three orientations due to their rolling directions. Two hardening models (isotropic and kinematics) are used in the model to study the effect of the hardening assumption on the simulation results. The effect of die and punch corner radius on the springback are also studied numerically. The 3D simulation of springback is modeled using the finite element code, Ansys10. The accuracy of the model is verified by a comparison between the numerical and experimental results. The obtained results show that increasing the blank holder force, friction coefficient and sheet thickness and decreasing the sheet anisotropy would result in the decreasing of springback and side wall curl due to increasing of plastic strain in the specimens.

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