Design and manufacturing of sheet metal bending and spring back testing rig

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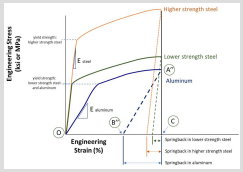
Abstract

This project is aiming to manufacturing of small-scale bench top sheet metal bending rig to bend the sheet metals and measure the value of spring back angle. Sheet metal bending rig was designed including the table and the different parts. The design of the different parts were assembled and using Solid Works. The suitable materials were selected for manufacturing of the different parts. The available spring back measuring devices were searched and bought to be used for measuring the sheet bent angle after deformation. Some sheet metals, such as aluminum, stainless steel and galvanized steel in different sheet thicknesses (0.5, 1.0 and 1.5 mm) were provided from the local commercial market to be test for spring back. Sheet metal samples were cut for bending and tensile tests. Tensile tests were performed to characterize the commercial materils. The spring back was performed on the manufactured rig and the results show that the rig has successfully used to for testing spring back.

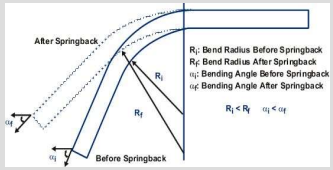
Project Objectives

- **Design and manufacturing a rotary bending machine for spring back testing.**
- **Preform spring back testing and data collection for different materials , thicknesses, and bending angles.**

Spring back



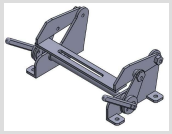
Spring back in different materials



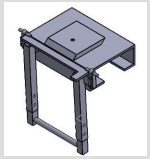
Spring back angle

SolidWorks modeling

Rotary Bending Machine

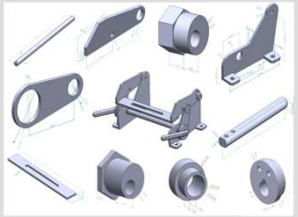


Clamping mechanism

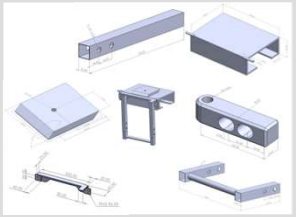


Bending mechanism

SolidWorks modeling parts



Clamping mechanism parts

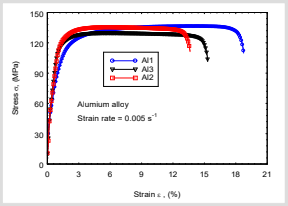


Bending mechanism parts

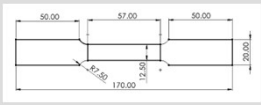
Part name	SolidWorks drawing	Actual parts	Material	Machining process
Base			D2 Steel	Bending, wilding
Rocker			A36 Structural Steel	Laser cutting, wilding
connecter			A36 Structural Steel	Drilling
3angle die 1mm fillet			D2 Steel	Laser cutting, heat treating (quenching)
Side			A36 Structural Steel	Laser cutting, wilding
cantilever lever			A36 Structural Steel	Laser cutting
clamp arm			A36 Structural Steel	Laser cutting
clamp brace			A36 Structural Steel	Laser cutting
clamp over center			Low carbon Structural Steel	Turning, drilling
clamp pivot			Low carbon Structural Steel	CNC, drilling
over center shaft			A36 Structural Steel	Drilling
cantilever spacer			Low carbon Structural Steel	Turning, drilling
clamp cam			Low carbon Structural Steel	CNC, drilling
clamp handle			Low carbon Structural Steel	Grinding, drilling
Table			A36 Structural Steel	Bending, wilding, Laser cutting,

Chemical composition of applied test and manufacturing materials

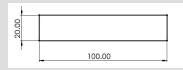
Elements (wt. %) Material	C	Si	Mn	P	S	Ni	Cr	N	Cu	Fe	Ti	Mo	V
stainless steel (304)	0.048	0.5	1.08	0.029	0.003	8.04	18.22	0.05	--	--	--	--	--
galvanized steel	0.2	--	1.35	0.1	0.04	--	--	--	--	--	--	--	--
Aluminum-3003	--	0.08	1.04	--	--	--	--	--	0.140	0.53	0.012	--	--
D2 steel	1.55	0.3	0.4	--	--	--	11.8	--	--	--	--	0.8	0.8
Low carbon steel	0.023	--	0.193	0.008	--	--	0.021	--	0.028	99.64	--	--	0.002



Tensile test Stress strain Diagram



ASTM E8 tensile specimen



Bending test sample

Bent samples at 135°, R = 1 mm

Bent samples at 90° , R = 1 mm

Spring back at 135°, R = 1 mm fillet
Based on the standard error digi. Ruler 1 is further used

Spring back at:
(a) bending radius 1, and 3 mm (b)bending angles 90 and 135°

Conclusions & Recommendations

- Rotary sheet bending and spring back testing rig has been manufactured and satisfactorily used.
- It has been found that the spring back increases with increasing the fillet radius.

Recommendation

Improve the measuring system i.e. applying laser to measuring system.

References

[1] Roark, R. J., & Young, W. C. (2002). Roark's formulas for stress and strain (7th ed.). McGraw Hill.

[2] Stoudt, Mark R., Lyle E. Levine, and Li Ma. "Designing a Uniaxial Tension/Compression Test for spring back Analysis in High-Strength Steel Sheets." Experimental mechanics 57.1 (2017): 155-163.

[3] Science direct metal forming process (2015).

[4] ASTM intellectual (Standard Test Methods for Bend Testing of Material for Ductility) 2022.

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