

Study on the characterization of the dynamic material properties of sheet metal for auto-body considering the pre-strain effect

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ABSTRACT

Most parts of auto-body are produced through the sheet metal forming process, and during this process they have change of thickness and residual stress and strain remain. In this paper, to specify dynamic material properties considering this pre-strain effect, materials SPCEN, SPRC45E and SPRC35R were selected and were imposed 5, 10% pre-strains. After that using the high speed material testing machine, materials were tested at given strain rates of between 0.003 and 50 s⁻¹. It was found from experimental results that in case of SPCEN and SPRC35R, the yield stress and ultimate stress were increased due to pre-strain effect at strain of over 10 s⁻¹ but SPRC45E was not affected by pre-strain effect.

: Pre-strain effect(), Strain rates(), High speed material testing machine()

1.

가

가

(sheet metal forming)

가

/sec

가

/sec

(intermediate strain rate)

*

Table 1 Material constants from static tension tests

Material	Thickness (mm)	Yield stress (MPa)	Ultimate stress (MPa)	Elongation (%)
SPCEN	0.70	148.5	295.1	60.7
SPRC45E	1.20	312.1	465.0	45.8
SPRC35R	1.40	191.3	359.8	44.3

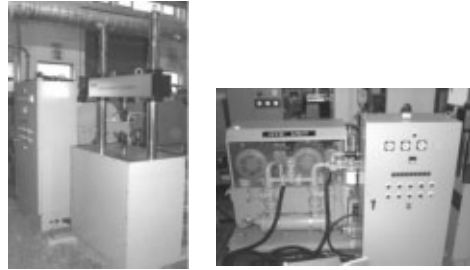


Fig. 1 High speed material testing machine: (a)frame of machine; (b)hydraulic unit

500/sec

가 가

가

가

10%

5, 10%

50/sec

(stroke) 100mm

45kW

700L

2.

168L/min

2.1

가

가

Kistler 9341B (piezo-electric type)

SPCEN, SPRC35R
SPRC45E

Sentech LDT(Linear Displacement Transducer)

ASTM, KS, JIS

Table

1

2.2

Fig. 1

800mm × 400mm ×

2300mm

300kgf/cm²,

⁸⁾

(L),

30 kN

4000mm/s

(W) ,

(R)

Table 2 Material testing condition

Material	Test Machine	Strain Rate (/sec)	Gauge Length (mm)	Velocity (m/s)	No.(ea)		
					0% Pre-stn	5% Pre-stn	10% Pre-stn
SPCEN	Static machine	0.003	50	0.000150	3	3	3
	High Speed testing machine	1	20	0.0216	3	3	3
		10	20	0.216	3	3	3
		20	20	0.432	3	3	3
		50	20	1.08	3	3	3
SPRC45E	Static machine	0.003	50	0.000150	3	3	3
	High Speed testing machine	1	20	0.0216	3	3	3
		10	20	0.216	3	3	3
		20	20	0.432	3	3	3
		50	20	1.08	3	3	3
SPRC35R	Static machine	0.003	30	0.00009	3	3	3
	High Speed testing machine	1	30	0.0316	5	5	5
		10	30	0.316	5	5	5
		20	30	0.632	5	5	5
		50	30	1.58	5	5	5

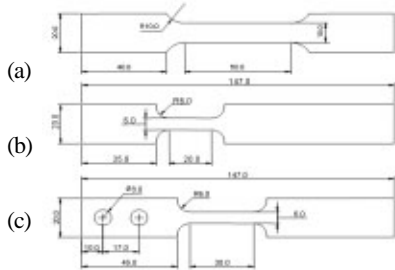


Fig. 2 Schematic description of specimen: (a)L50W10R10; (b)L20W6R6; (c)L30W6R6

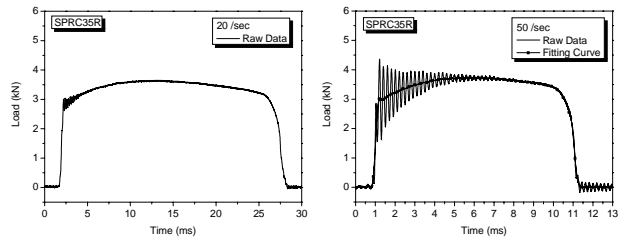


Fig. 3 FFT(Fast Fourier Transforms) smoothing

Fig. 2
 3 SPCEN SPRC45E
 L50W10R10,
 L20W6R6 가
 SPRC35R
 가
 L30W6R6

가 20/sec
 ,
 FFT(Fast Fourier
 Transforms)
 . Fig. 3
 SPRC35R

3.

가

Table 2

3.1 SPCEN

148.5MPa

가 SPCEN

(extensometer)

5, 9%

0.003, 1, 10, 20, 50/sec

가 가

10mm

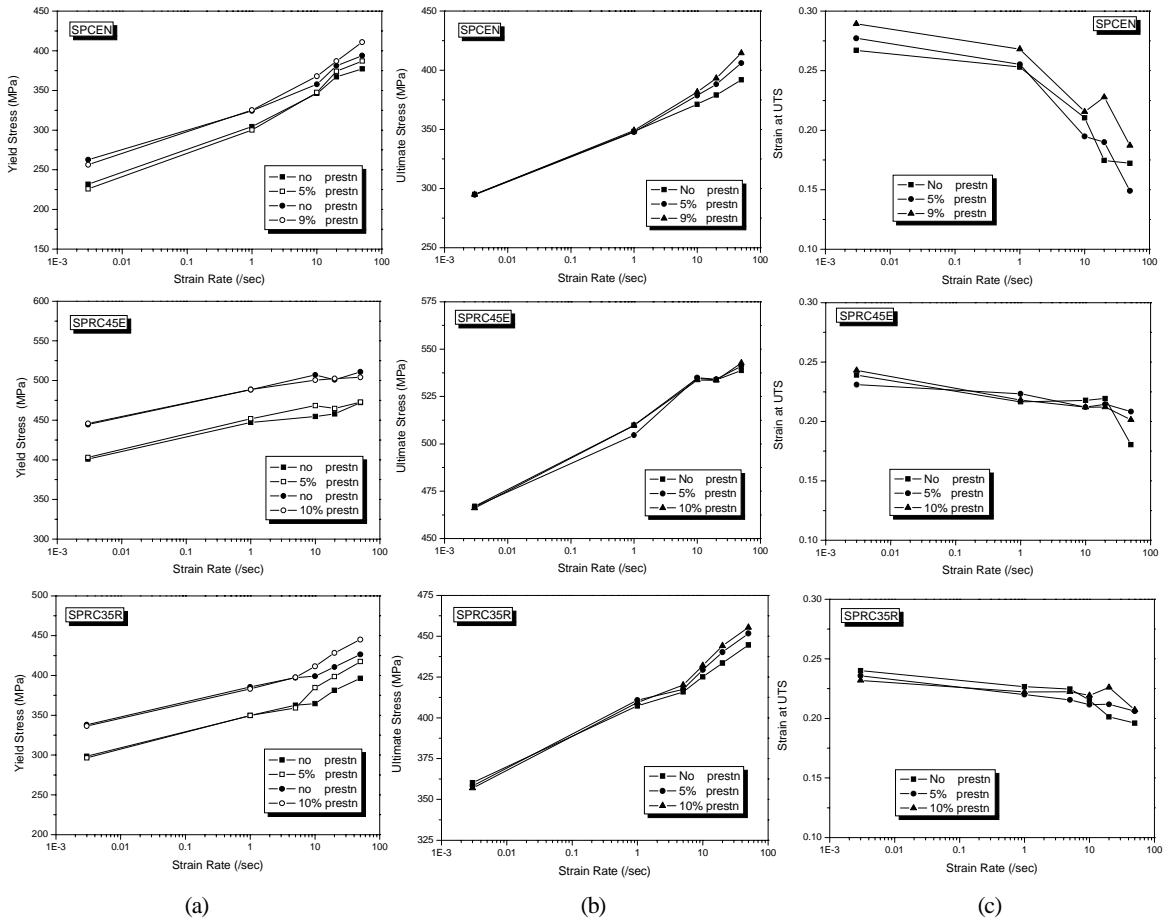


Fig. 5 Dynamic material properties considering the pre-strain effect: (a) yield stress for strain rate with pre-strain effect; (b) ultimate stress for strain rate; (c) strain at ultimate stress for strain rate

SPCEN

(necking)

4. 가

가

4.1

. Fig. 5-(b)

가

Fig. 5-(a)

. SPCEN

SPCEN SPRC35R

SPRC35R 10, 20, 50/sec

5, 10% 가

10, 20, 50/sec

SPRC45E

가

SPRC45E

4.2

Fig. 5-(c)

가

가 가

5.

가

SPCEN, SPRC35R

SPRC45E

5, 10%

50/sec

1) SPCEN, SPRC45E, SPRC35R 50/sec

2) SPCEN, SPRC35R

10/sec

가 SPRC45E

3) SPCEN, SPRC35R

10/sec

가

가

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