Tailored Blank에서 절단이 용접품질에 미치는 영향

1998. 10. 30

이 경 돈

고등기술연구원

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내용

- ◆ 테일러드블랭크(Tailored Blank) 기술
- ◆ 연구 목표
- ◆ 전단(Shearing) 품질
- ◆ 용접(Laser Welding) 품질
- ◆ 전단실험(Experiment on Shearing)
- ◆ 용접실험(Experiment on Welding)
- ◆ 결론

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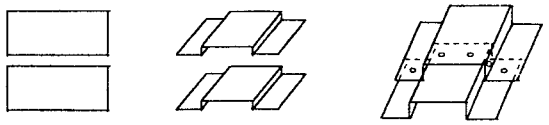
Tailored Blank 기술

◆ 기존차체성형기술과 비교

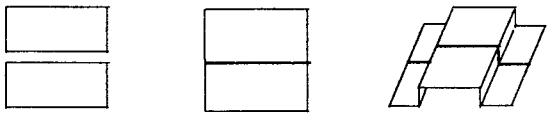
- Conventional stamping

Blank → Stamping → Spot welding



- Laser welded Tailored Blank

Blank/Shear → Laser butt-welding → Stamping



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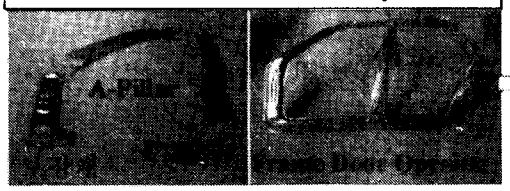
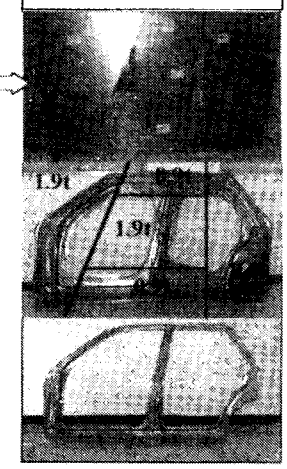
Tailored Blank 기술

Conventional Auto Body	Tailored Blank Body
	

장점	부품수 (개)	4	1
	무게 (kg)	15.68	13.72
	금형수 (개)	19	5
	금형비절감 (백만원)	기준	-***
	용접투자비 (백만원)	기준	-***
	설계자유도 증가 → 최적설계		
단점	시스템 초기 투자비 큼 → 비용절감 중요 TB 용접 및 금형/성형기술 확보 → 생산기술을 고려한 설계 가이드		

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연구목표

✓ "Laser Welded Tailored Blank 에서 fine shearing이 매우중요하다."

- ◆ fine shearing 이 필수 ?
- ◆ Shearing이 Laser Welding 에 어떤 영향을 주나?
- ◆ Shearing 품질의 정의와 정량적 표현?
- ◆ Laser Welding 품질의 정의와 정량적 표현?
- ◆ Shearing 품질과 Welding 품질의 관계는?
- ◆ 최적의 TB 품질을 얻기 위해서는?

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Shearing

◆ Conventional Shear vs Fine Shear

	Conventional	Fine
Blade Angle	1-3 degree	< 1 degree ?
Clearance	10-15 % t	0.3-1.5% t
Blank Hold	Blank Holder	Blank Holder
C/B Force	None	Exist
Shearing Mechnism	Shear+Fracture (1/3 shear face)	Shear (more than 80% shear face)

* Masao Murakawa et al : J. of Mat. Processing Tech. Vol66,(1997),pp232-239
* T.C. Lee et al:J.of Mat. Prcessing Tech, Vol48,(1995),pp105-111

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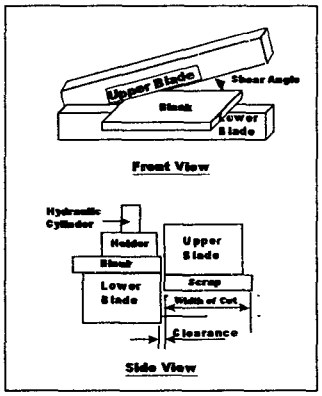
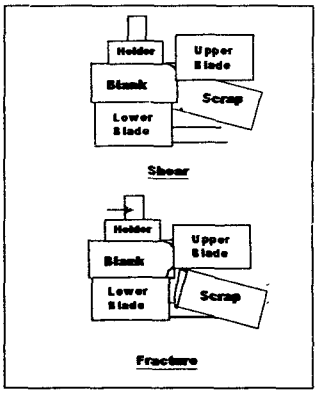
Shearing Process

◆ **Down - Cut - Shear type Shearing Machine**





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전단품질 (Shearing Quality)

◆ 맞대기 틈새에 영향을 주는 전단 품질

◆ 전단길이 방향의 형상 (sheared contour)

- ◆ 진직도 (straightness) : Rt
- ◆ 굴곡 형상 (contour shape) : Ca

◆ 전단단면의 형상 (shear plane geometry)

- ◆ 롤오버 (roll over) : R
- ◆ 전단면각 (shear plane angle) : As
- ◆ 전단율 (ratio of shear face) : Rs

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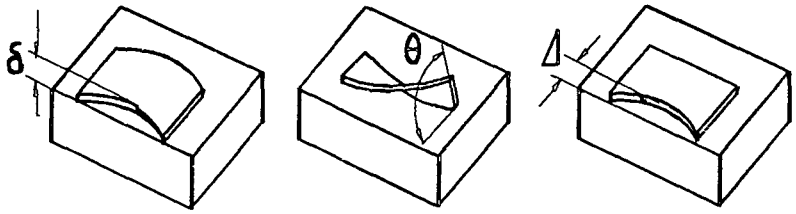
Shearing Quality

◆ Sheared Contours in general



Bow Twist Camber

◆ Sheared Contours in Clamped Sheets ?

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전단품질 (Shearing Quality)

✓전단 단면 형상
(Shear Plane Geometry)

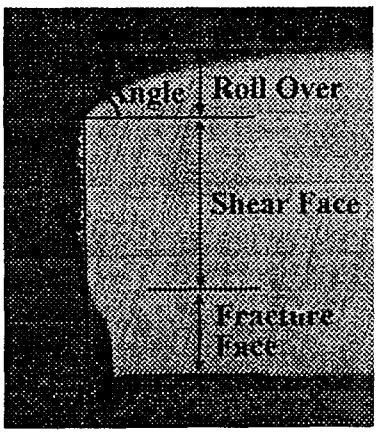
◆ Roll Over

◆ Shear Face

◆ Fracture Face

◆ Burr

◆ Shear Plane Angle



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Laser Butt-Welding Quality

- Internal Defects : Porosity
  Impurity
  Crack
- Shape Defects : Incomplete Penetration
  Lack of Fusion
  Linear Mismatch
  Undercut
  Convexity/Concavity

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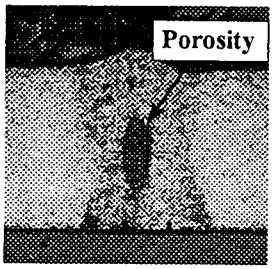
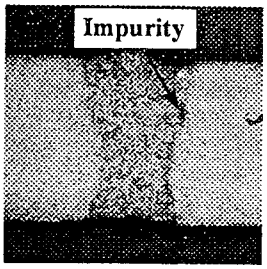
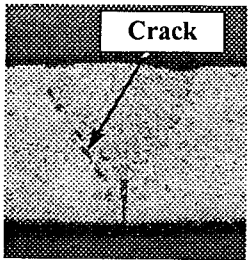
Internal Deffects in Welding



Porosity

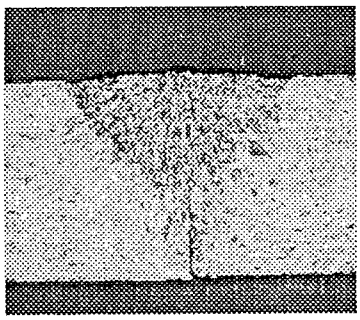


Impurity

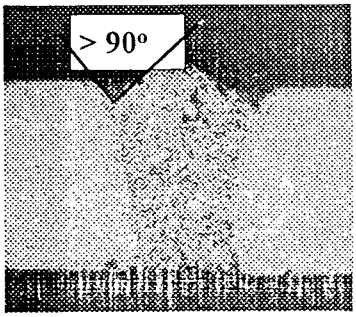


Crack

Shape Deffects in Welding

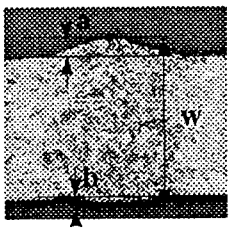


Incomplete Penetration

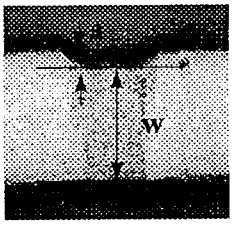


Undercut (Angle > 90°)

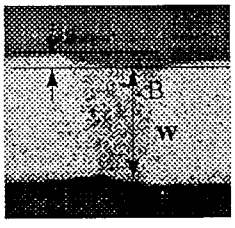
Shape Deffects in Welding



Concavity



Convexity



Linear Mismatch

a/t	≤ 0.1t
b/t	≤ 0.1t
(a+b)/t	< 0.1t
w	≤ 1.10t

* GM Eng. Standard 4485M
* ISO 13919-1:1996

Experiments

✓ 전단실험

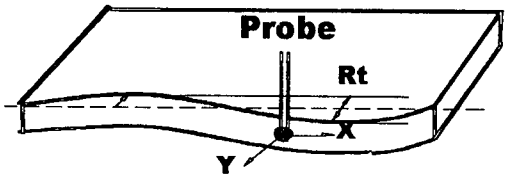
- ◆ 일반전단기로 얻을 수 있는 최적전단품질 ?
- ◆ 이상적인 전단품질로서 밀링가공과 비교.

✓ 레이저용접실험

- ◆ 전단판재와 밀링판재의 용접품질의 차이 ?
- ◆ 인위적 틈새에 따른 용접품질의 변화 관찰.

Experiment on Shearing

- ◆ **Target : find the optimal shearing condition**
- ◆ **Sheet : Material : SPCEN (0.006wt%C)**
  Thickness : 0.9mm
  Length : 1000mm
- ◆ **Taguchi's Experimental Design**
- ◆ **Measure x- and y- coordinates by CMM**
- ◆ **Calculate Straightness(Rt), Average, Butt-Joint Gap**



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Experiment on Shearing

◆ 다구찌 실험계획 (L9, 3회 반복)

	factors			
	Shear Angle	Clearance	idle	Width of cut
	column no.			
trial no.	1	2	3	4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

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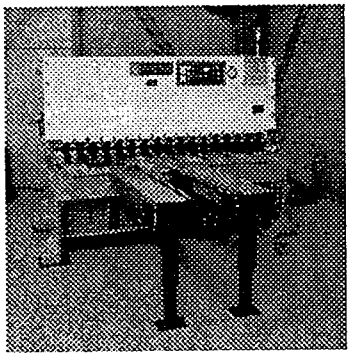
Experiment on Shearing

◆ Down-Cut-Shear type Shearing Machine

◆ Specifications

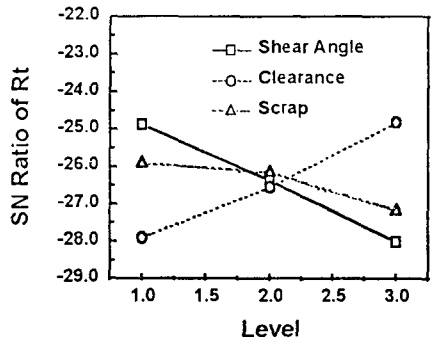


Shear Capacity	Max 3.2t
Shear Length	2,550mm
Working Pressure	140kg/cm^2
Shear Angle	Adjustable
Clearance	Adjustable
Stroke Length	110mm
Stroke Speed	70mm/s

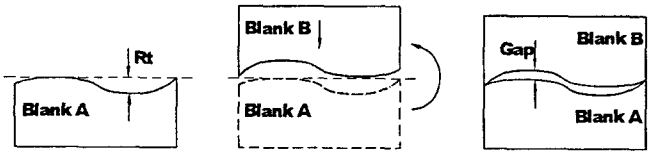
Results on Straightness, Rt

◆ S/N ratio of Rt at level i = -10 log(($Rt_{i1}^2 + Rt_{i2}^2 + Rt_{i3}^2$)/3)

◆ Optimal shearing condition : shear angle at level 1
clearance at level 3



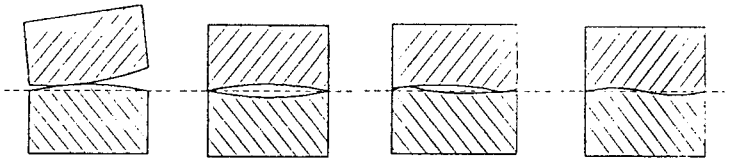
Gap Calculation



Rt Gap

1. 용접에 직접영향을 주는 절단 품질은 맞대기 틈새임.
2. Blank A, B 의 전단길이방향 형상 데이터에서
맞대기틈새를 계산.

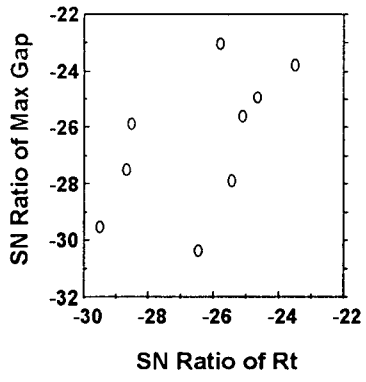
Gap Geometry & Average



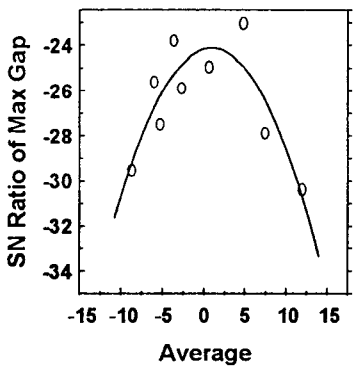
Average > 0 Average < 0 Average near 0 Average = 0

Effect of Rt, A on Max. Gap

◆ Effect of Rt



◆ Effect of Average, A



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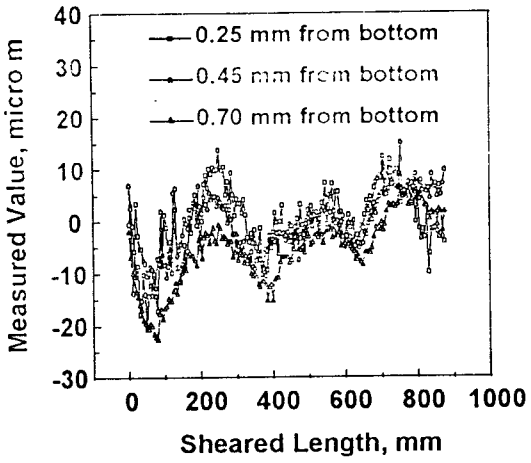
Shear Plane Angle



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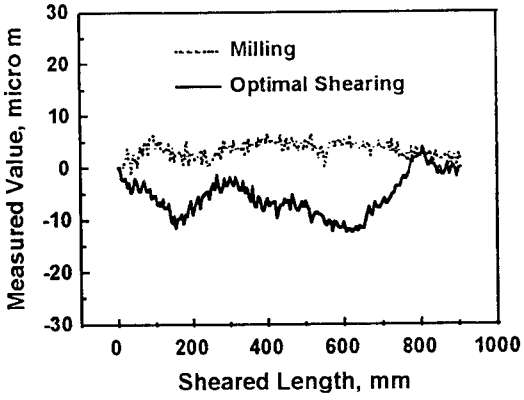
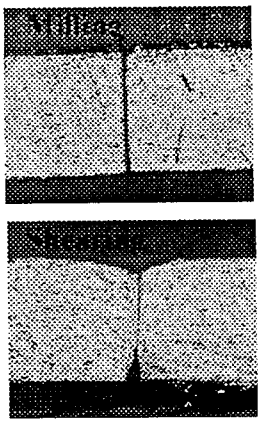
Optimal shearing vs. Milling

◆ Sheared Contours



◆ Cross Section



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Experiments on Welding

◆ Target 1 : compare the welding quality of milled sheets with one of optimal sheared sheets

◆ Target 2 : find the effects of gap on welding quality according to 4 gap sizes given by gap gauges

◆ Sheet : Material : SPCEN (0.006wt%C)
Thickness : 0.9mm
Length : 1000mm

◆ Experimental Design

◆ Observe the optical microstructure of weld beads

◆ Calculate "gap effect"

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Experimental Design

◆ Experimental Design for Welding

인자	수준	내용
전단품질	2수준	밀링판재, 최적전단판재
인위적틈새	3수준	0.0, 0.05, 0.10, 0.15 (단위 : mm)

◆ Laser Welding Condition

Laser power	Speed	Shield gas	Flow rate	Focal length
4kW	6m/min	Ar	30 liter/min	250mm

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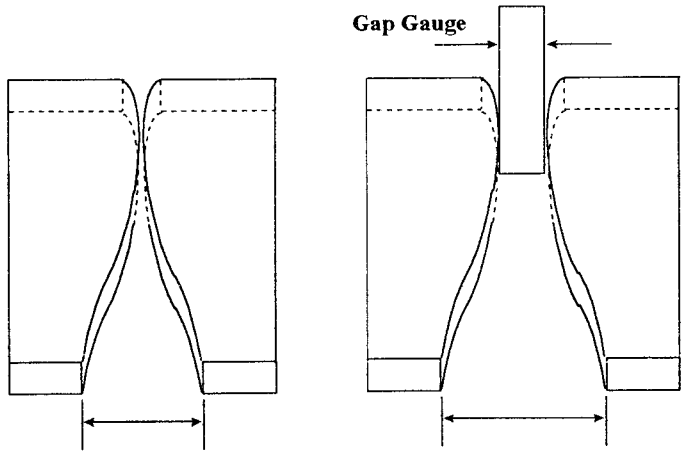
Gap with gap gauge



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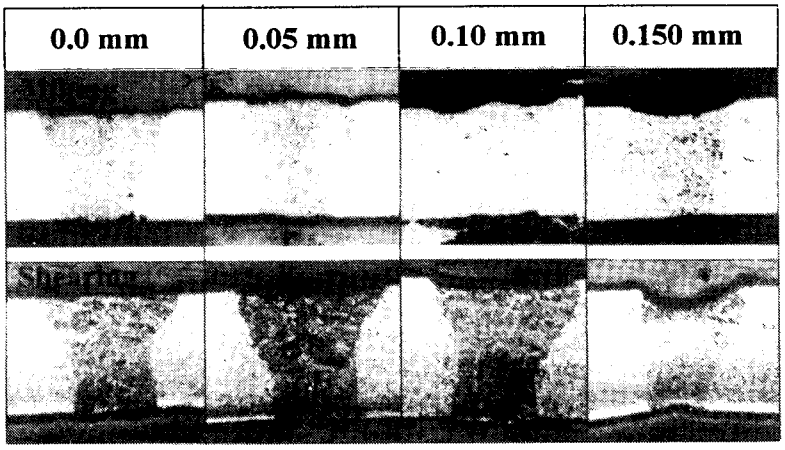
Optical Microstructure

◆ weld bead according to gap sizes by gap gauge



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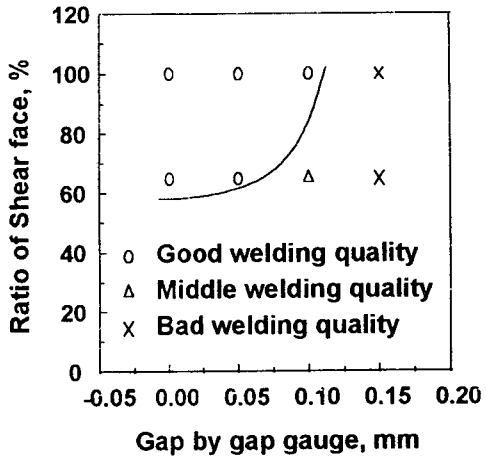
Gap effect by optimal shearing



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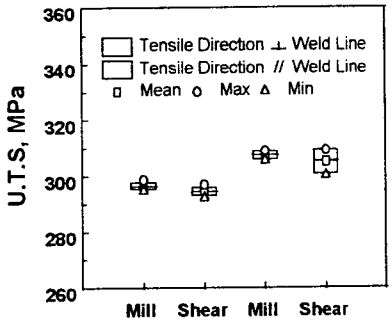
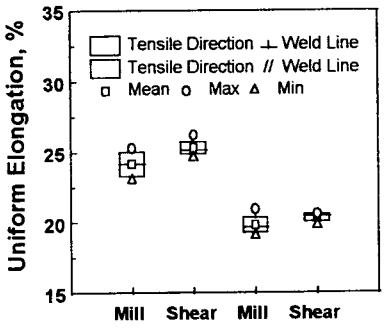
Optimal Shearing vs. Milling

◆ Ultimate Tensile Strength



◆ Uniform Elongation



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Conclusions

- 다운컷시어형 일반전단기로 다구찌방법에 의하여 최적조건을 구하였다. 주요인자는 상부날과 하부날간의 클리어런스와 전단각이다.
- 최적조건의 일반전단판재로 좋은 용접품질을 얻었다.
- 맞대기 틈새를 발생시키는 전단품질은 단면형상 (전단율, 전단면각, 롤오버)과 진직도이다.
- 진직도 **Rt** 와 측정평균으로 길이방향형상을 나타낼수 있다.
- 단면형상이 틈새에 주는 영향을 틈새효과로 정의하고 그 크기를 계산하여 실험과 비교하였다.

고등기술연구원