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Strength Properties of Aluminum/Aluminum, and Aluminum/Steel Joints for Light Weighting of Automotive Body

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ABSTRACT

For the purpose of lightening automotive body, we examined strength properties of four kinds of joining methods for aluminum to aluminum or aluminum to steel. These joining methods examined are self-piercing riveting(HENROB riveting), mechanical clinching(TOX clinching), hybrid of HENROB riveting and adhesive bonding(HENROB-bonding) and hybrid of TOX clinching and adhesive bonding(TOX-bonding). The strength properties tested are shear strengths, tensile strengths and fatigue strengths. The strength properties of aluminum/aluminum joints and aluminum/steel joints were compared with those of 0.8t steel/steel spot-welded and weld-bonded joints.

The results obtained are as follows:

(1) Strength properties of aluminum/steel joints are about equal to those of aluminum/aluminum joints.

(2) The strength properties of 1.6mm aluminum/aluminum joints by HENROB riveting and 1.3mm aluminum/aluminum joints by HENROB-bonding are equivalent to those of 0.8mm steel/steel joints by spot welding, and those of 1.5mm aluminum/aluminum joints by HENROB-bonding are equivalent to those of 0.8mm steel joints by weld-bonding.

(3) In the case of TOX clinching and TOX-bonding, the strength properties of less than 1.6mm aluminum/aluminum joints are less strong than those of 0.8mm steel/steel joints by spot welding.

*) The original was published by "The Adhesion Society of Japan" as an article in "Journal of The Adhesion Society of Japan" No. 11, Vol.34 (1998), pp.432-438

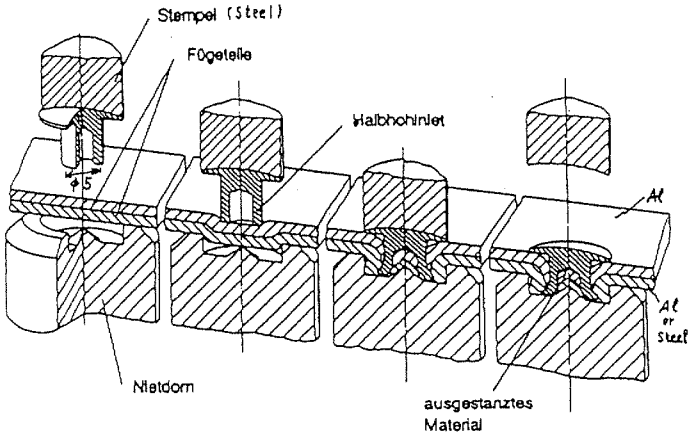

Fig. 1 Schematic illustration of the operational sequence of joining processes used for selfpiercing rivetting (Henrob rivet).

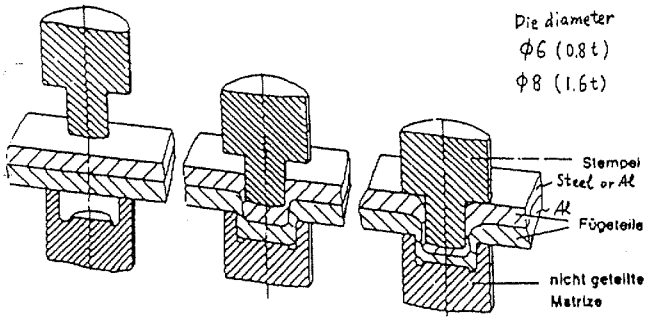

Fig. 2 Schematic illustration of the operational sequence of joining processes used for mechanical clinching (Tox clinching).

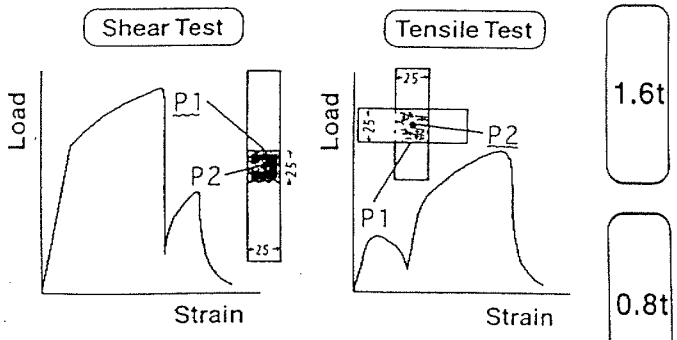

Fig. 3 Load strain diagrams of tensile shear tests and cross lap tensile tests of hybrid joints (Tox bonding, Henrob-bonding and weld-bonding). [5mm/min]

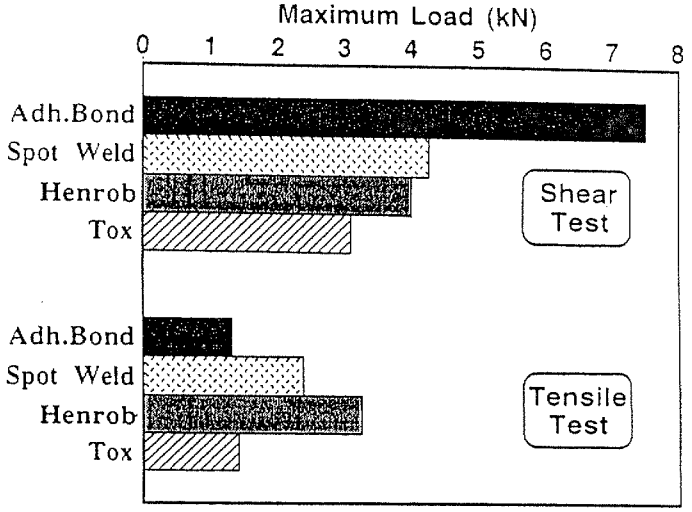

Fig. 4 Strengths of conventional joints (Tox clinching, Henrob rivetting, spot welding and adhesive bonding). [1.6mm Al/Al]

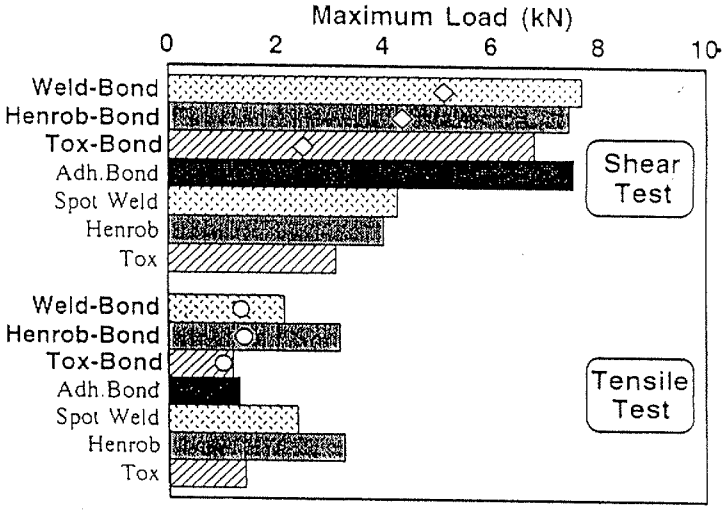

Fig. 5 Strengths of hybrid joints. [1.6mm Al/Al] ◇: P_2, ○: P_1

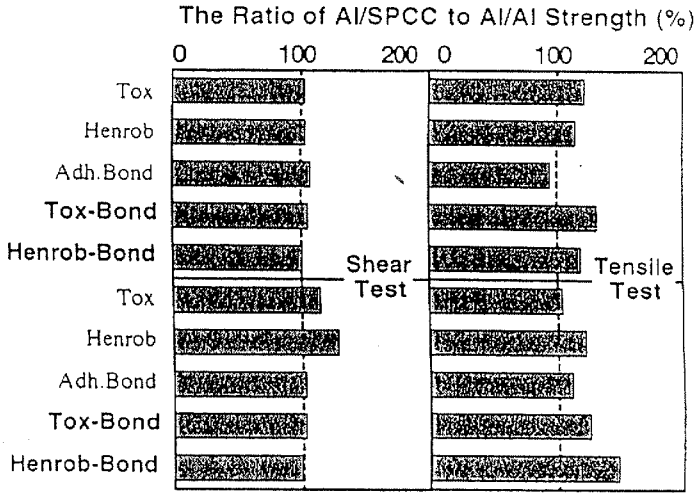

Fig. 6 The ratio of Al/steel strengths to Al/Al strengths.

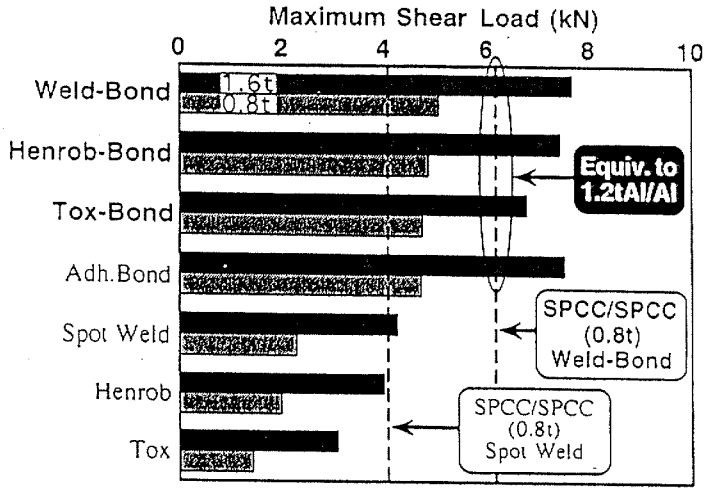

Fig. 7 Effects of adherend's thickness on shear strengths.

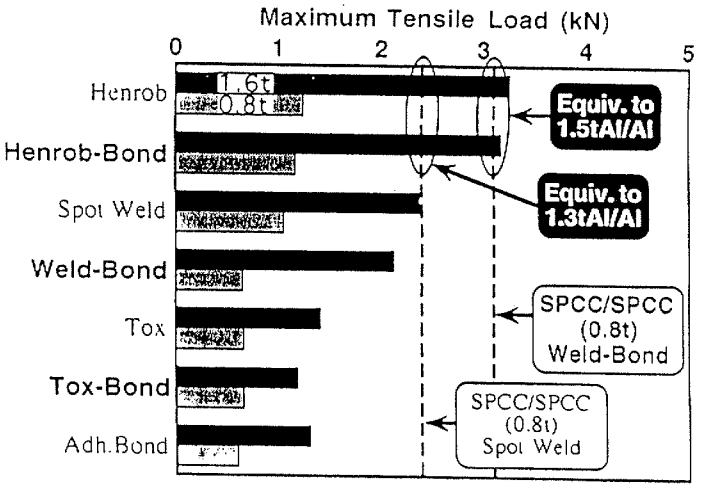

Fig. 8 Effects of adherend's thickness on tensile strengths. [Al/Al]

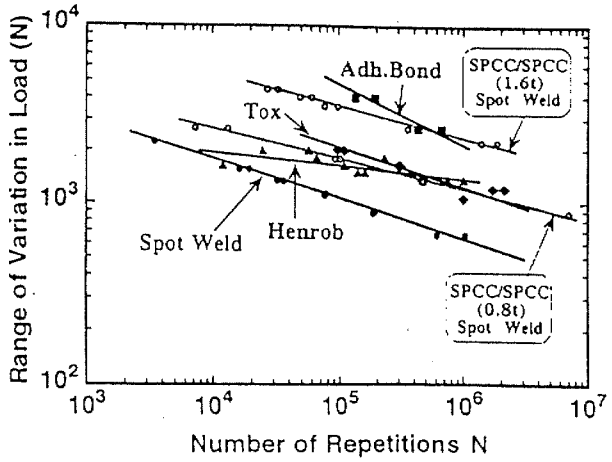

Fig. 9 Fatigue strengths of conventional joints (1.6mm Al/Al) compared with those of spot welded steel/steel joints. [20Hz, 5%=0.1]

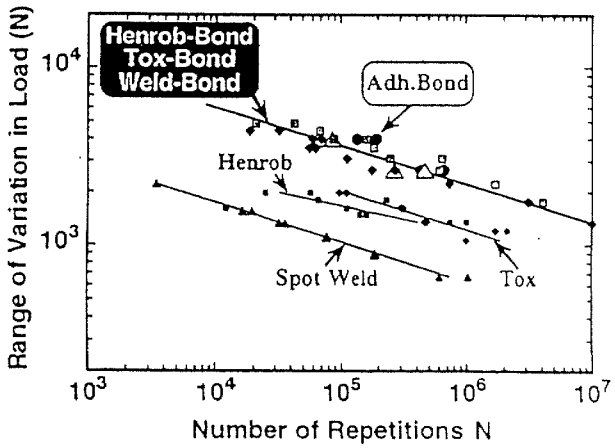

Fig. 10 Fatigue strengths of hybrid joints compared with those of conventional joints. [1.6mm Al/Al]

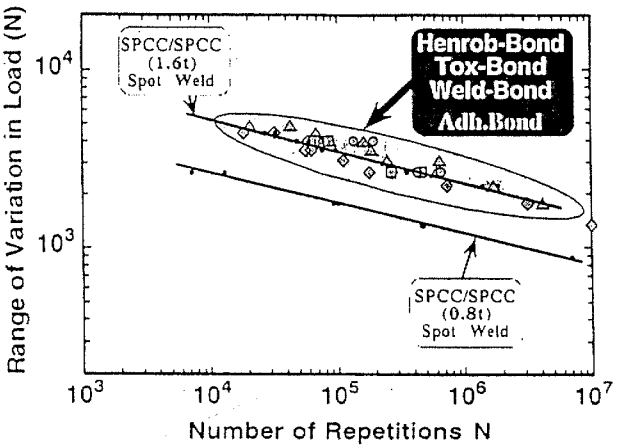

Fig. 11 Comparison of fatigue strengths of hybrid joints and adhesive bonded joints (1.6mm Al/Al) with the strengths of spot welded steel/steel joints.

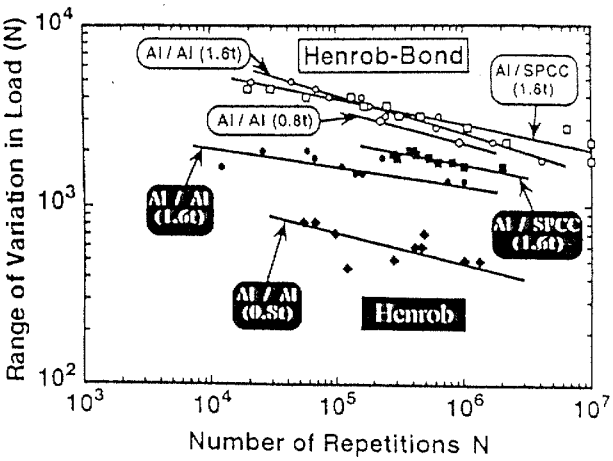

Fig. 12 Effects of the adherend's thickness and different kinds of metals on fatigue strengths.

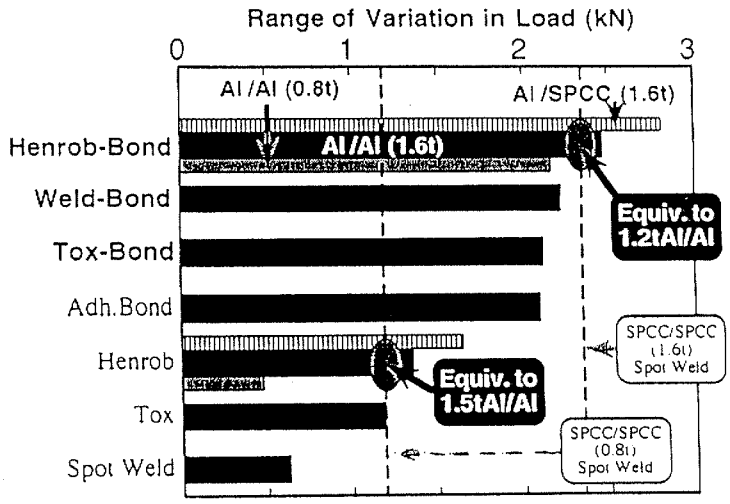

Fig. 13 Fatigue strengths at 10^6 cycles.

Table 1 Thickness of aluminum sheet equivalent to 0.8mm steel sheet.

Joining method of 0.8mm Steel/Steel	Joining method of aluminum/ aluminum	Equivalent thickness of aluminum		
		Shear strength	Tensile strength	Fatigue strength
Spot-weld	Henrob-bond	<0.8mm	1.3mm	<0.8mm
	Tox-bond	<0.8mm	>1.6mm	<1.6mm
	Henrob	1.6mm	1.3mm	1.5mm
	Tox	>1.6mm	>1.6mm	1.6mm
Weld-bond	Henrob-bond	1.2mm	1.5mm	1.2mm
	Tox-bond	1.2mm	>1.6mm	>1.6mm
	Henrob	>1.6mm	1.5mm	>1.6mm
	Tox	>1.6mm	>1.6mm	>1.6mm