







**Table 1 — Chemical Compositions and Mechanical Properties of Specimens**

Material	Chemical Compositions (mass %)								Mechanical Properties			
	C	Si	Mn	P	S	Cr	Cu	Sn	C + Mn/6	YP (N/mm <sup>2</sup> )	TS (N/mm <sup>2</sup> )	El (%)
SD345	0.28	0.27	1.08	0.014	0.018	0.16	0.26	0.016	0.46	402	596	25
Spec.	≦0.27	≦0.55	≦1.60	≦0.040	≦0.040	—	—	—	≦0.50	345 to 440	490 ≦	20 ≦

welding under conditions of a heating temperature of 1273 K and upsetting length at 30 mm. A tensile stress arises in the region of the front edge. This region extends into the prescraping area, and the value of the tensile stress increases up to 40 MPa when the edge passes the interface of the gas pressure weld — Fig. 5. Consequently, if joint strength is low, a crack is caused by this tensile stress. In other words, a gas pressure weld is considered good when a crack is not observed on the surface subjected to hot shearing.

**Defect Generated by Hot Shearing Method**

Figure 7 shows an example of good weld appearance after hot shearing. A flaw is not observed on the weld surface. On the other hand, Figs. 8–10 show examples of welds that are judged to be inferior. Figure 8 shows a crack. Figure 9 shows a surface on which a line flaw is formed along the weld interface. Figure 10 shows a surface severely roughened by overheating. If these kinds of conditions are observed, the weld should be judged to be inferior.

Figure 11 shows plastic deformations from hot shearing revealed by FEM in both sufficient and insufficient gas pressure welds. Macrostructures of the hot shearing stage of gas pressure welds on steel bars are shown in Fig. 12. The shape in Fig. 12 closely corresponds to that in Fig. 11. This shape can come from stress distributions as shown in Fig. 6. Accordingly, an evaluation of gas pressure weld quality can be accomplished by flash removal with the hot shearing method.

**Reliability of Flash Removal by Hot Shearing Method**

**Quality Inspection Method**

The reliability of flash removal by hot shearing as a quality inspection method is investigated by comparing it with other inspection methods. Penetrant testing and ultrasonic testing were used as comparisons. The reliability of each method of inspection, which was done after flash removal, was determined from the results of tensile and bend tests of welded joints. In tensile tests, tested joints that fractured in the base metal were judged to be ac-

**Table 2 — Comparison of Tensile Test Results and Inspection Results**

	Hot Shearing Method		Ultrasonic Method		Penetrant Method	
	Acceptable	Unacceptable	Acceptable	Unacceptable	Acceptable	Unacceptable
Qualify	61	1	59	3	62	0
Disqualify	10	63	19	54	23	50
Misjudgment ratio	(10 + 1)/135 = 8.1%		(19 + 3)/135 = 16.3%		(23 + 0)/135 = 17.0%	

**Table 3 — Comparison of Bending Test Results and Inspection Results**

	Hot Shearing Method		Ultrasonic Method		Penetrant Method	
	Acceptable	Unacceptable	Acceptable	Unacceptable	Acceptable	Unacceptable
Qualify	42	2	43	2	45	0
Disqualify	7	49	13	42	12	43
Misjudgment ratio	(7 + 2)/100 = 9.0%		(13 + 2)/100 = 15.0%		(12 + 0)/100 = 12.0%	

ceptable; those that fractured at the weld interface were judged to be unacceptable. In bend tests, on the other hand, the tested joints that were bent beyond 90 deg without cracking were judged to be acceptable, and those that broke or cracked at less than a 90-deg bend were judged to be unacceptable. Steel bars used in tests are those for concrete reinforcement with SD345 (Ref. 9) of nominal diameter 31.8 mm. Table 1 shows the chemical compositions and mechanical properties of the steel bars used.

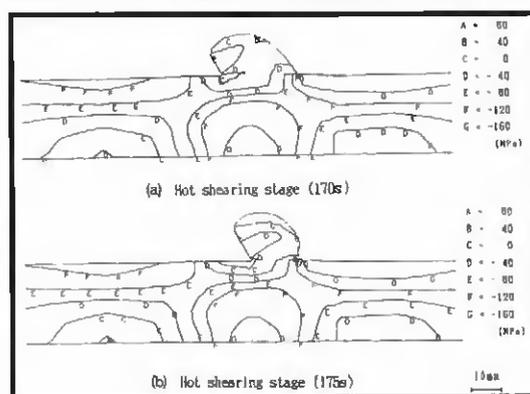


Fig. 6 — Axial stress distributions by hot shearing.



Fig. 7 — Appearance of a good weld.



Fig. 8 — Example of a crack observed on the surface.



Fig. 9 — Examples of line flaw observed on the surface.



Fig. 10 — Examples of surface roughened by overheating.

