EFFECT OF COLD PLASTIC DEFORMATION ON GAS PIPELINE RESISTANCE AND TOUGHNESS PROPERTIES

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INTRODUCTION

Large diameter pipes for natural gas and oil-products transport, are produced out of a large range of steels (pearlitic-ferrite, martensitic-ferrite, bainitic) and by two operating technologies: the U-O and ringing deformation processes. Studies on plate parameter variations induced by cold working practice in pipe forming operations have been performed especially concerning the use of U-O process. According to this view, in the case of pearlitic-ferrite steels, significant decreases in yield strength values have been noticed on pipe, in comparison to those determined on plate.

The present paper includes an analysis of the changes induced in the tensile properties of 14 mm plates by their ringing and/or expanding into 122o mm diameter pipes.

EXPERIMENTAL RESULTS

The chemical composition of X6o grade of steel, industrially produced and formed, used in the experiments, is shown in Table 1 and the tensile properties required for the pipes are shown in Table 2.

TABLE 1 - The chemical composition of experimental steel (%)

Steel grade	C max	Mn max	Si max	P max	S max	V min	Nb min
X6o	o.26	1.35	o.35	o.o4	o.o5	o.o2	o.oo5

TABLE 2 - Tensile properties required for the pipes

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Steel grade	R_m min (MPa)	$R_{po.5}$ min (MPa)	$A_{5o.8}$ min (%)	KVat 0^oC min (J)
X 6o	525	42o	22.5	27

The susceptibility to the Bauschinger effect of the steel has been verified on normalized and controlled rolled plates,according to the possibilities of the industrial production.At the same time the effect of cold working technology has been determined by studying the property variations resulted from ringing and from ringing and expanding,respectively(Figures 1-4).The experiments performed and presented in Figures 1-4,have evinced certain changes of the tensile property values,due to cold working,especially in the case of relatively high yield strength values.In line with these experiments,minimum values of the tensile properties determined on rolled plates have been assesed,in order to meet the level required by pipe design.

In Table 3 main statistical parameters are given,for the tensile property values distribution on a lot of 1oooo pipes.

TABLE 3 - The main statistical parameters of tensile values distribution,as determined on a lot of 1oooo pipes

	Min Val.	Max Val.	Average	Modulus	Dispersion
Ultimate tensile strength,R_m(MPa)	6o5	7o7	653	649	4.7
Yield strength, $R_{po.5}$(MPa)	442	569	5o4	5o6	6.4
Ultimate elongation $A_{5o.8}$(%)	26	38	32	34	8.3
Fracture energy at 0^oC,KV(J)	29	8o	54	46	17.3

In,conclusion,the industrial manufacturing of large diameter longitudinally welded pipes is a complex process,requiring a high control and a very narrow range for the technological parameters.

■ Normalized plate - Not expanded pipe
○ Controlled rolling plate - Not expanded pipe
• Controlled rolling plate - Expanded pipe

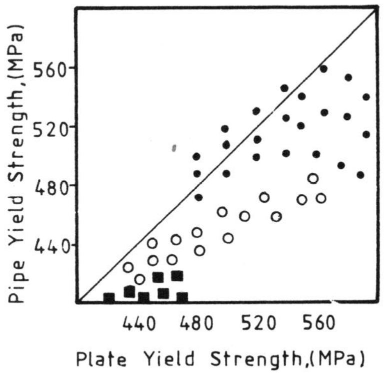

Figure 1: Yield Strength of Plate to Pipe

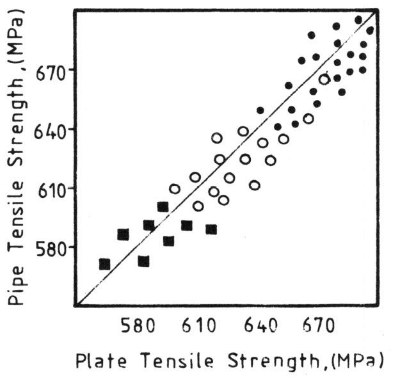

Figure 2: Tensile Strength of Plate to Pipe

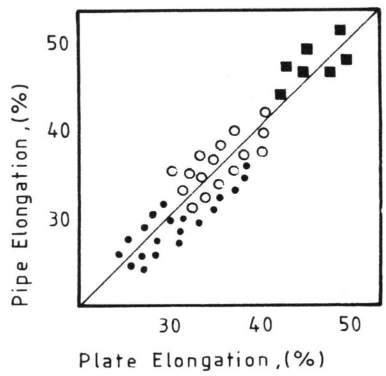

Figure 3: Elongation of Plate to Pipe

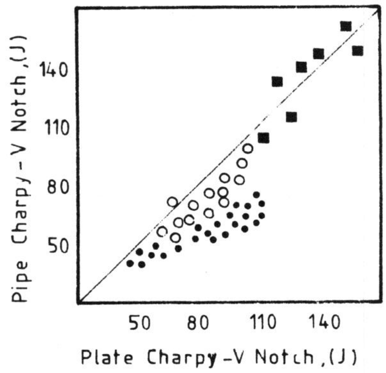

Figure 4: Charpy-V Notch of Plate to Pipe