UNITED STATES EXPERIMENTAL MODEL BASIN

NAVY YARD, WASHINGTON, D.C.

THE EFFECT OF JOINT ECCENTRICITY ON THE ULTIMATE STRENGTH OF PLATING IN COMPRESSION

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Summary

Unsymmetrical joints in plating introduce a certain degree of eccentricity which may be expected to reduce the ultimate compressive strength. Model tests show that with a lap joint, which represents the maximum eccentricity likely to be encountered in practice, the reduction in strength may amount to about 10 per cent.

Introduction

Reference (a)* requested recommendations regarding the degree of unfairness to be permitted in welded plating. Tentative suggestions were made in reference (b), which were principally based on theoretical considerations. An experimental investigation has since been made, in which unfairness of plating was introduced by the use of eccentric butt joints.

Models

Fourteen models were built and tested, the characteristics of which are listed in Table I. For all models the following quantities were constant:

Length-width ratio	$a/b = 3$
Thickness (nominal)	$t = 3/16$ in.
Modulus of elasticity	$E = 30 \times 10^6$ lb/in.^{2}
Yield point	$\sigma_{yp} = 41000$ lb/in.^{2}

The variables were:

(a) Eccentricities of t and 1/2 t were introduced by the use of joints shown in Fig. 1.

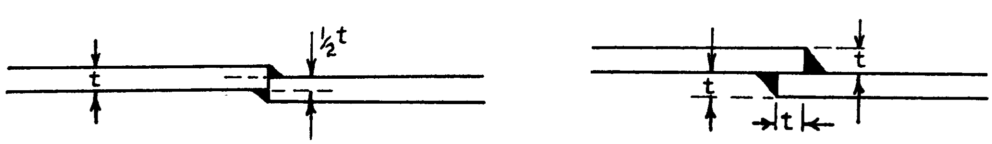


Fig. 1

*References are listed on page 3.

(b) The joint was located at either the third or half length of the model, corresponding to a crest or node position in the control models, which were of the same dimensions but without eccentricity.*

(c) Six models were wide, having b/t = 100; the remainder had b/t = 60. Two control models were made of each b/t ratio.

(d) The lateral edges of the narrow models were supported by (4" x 3/16") flanges (Fig. 2), whereas T stiffeners of the same sectional area (2.5" x 1.5" x 3/16") (Fig. 3) were used on the wide models. It has been found that both types of lateral edge support are practically equivalent to the theoretical condition of simply-supported edges.+

Results

The results are tabulated in Table I, in which comparisons are made on the basis of average ultimate stress (P/A). The average reductions in strength due to the presence of the eccentric joints are approximately:

Width/Thickness b/t	Eccentricity	
	t	1/2 t
60	7%	3%
100	11%	(none tested)

Some strain data were taken, as shown on the photograph ; but aside from indicating that the stress distribution in the plating is greatly altered by introducing an eccentric joint, the data were of little value in these tests.

The edge stiffeners deformed considerably at high loads, the degree of deformation being less for the control models than for the models with joints. With stiffeners of adequate rigidity and stability, it is therefore probable that the effects of the joints on ultimate strength would be less.

Conclusions

1. The ultimate strength of a simply-supported panel of initially flat plating in compression is reduced approximately 10% by the introduction of a lap joint.

2. Reducing the joint eccentricity decreases its effect on the ultimate strength.

3. The reduction in strength for a given eccentricity is less for narrow plates (lower b/t ratios).

*The theoretical 3-lobe buckling for a/b = 3 was obtained and may be clearly seen on the wide control model shown in Fig. 3.

+It is planned to discuss this question in a later report.

4. The reduction in strength would probably be decreased by increasing the rigidity of the lateral edge stiffeners used in these tests.

5. The above conclusions are considered valid for plating with adequate edge stiffening, with length-width (a/b) ratios of unity and greater, and with stiffener spacings up to 100 t.

6. It is noted that the degree of unfairness permitted by reference (c), Figure 20, does not generally exceed 1/2 t for the spacing of 60 t which should be employed for plating under compression. Since considerably more unfairness is permitted for widely-spaced stiffeners on thin plating, it is recommended that an allowance, based on the results of this report, be made in such cases where strength is important.

References:

(a) Bu.CandR letter No.S29-6-(2)(TB),EN7/A2-11 of 26 March 1934.

(b) Comdt.Wash. letter to Chief,Bu.CandR, NY5/S29-6(1) of 13 April 1934.

(c) General Specifications, Appendix 5, "Specifications for Welding", Edition of March 1937.

TABLE I

Compression Strength of Butt and Lap Welded Plates

1	2	3	4	5	6	7	8	9	10	
Model No.	b/t	Area A	Load P	P/A	Type of Model	Position of Weld	P/A Control Plate	Eccentricity	% of Strength of Mod. based on P/A from (8)	
4603	60	3.77	116000	30700		None	30700	None	100)	)100
4604	60	4.33	132700	30700	"	None	30700	None	100)	
4801*	60	3.75	113000	30100	"	1/2 a	30700	1/2 t	98)	
4803	60	3.56	105000	29500	"	1/3 a	30700	1/2 t	96)	97
4804	60	3.56	105000	29500	"	1/3 a	30700	1/2 t	96)	
4806	60	3.60	102200	28400	"	1/2 a	30700	t	93)	
4807	60	3.50	95600	27300	"	1/3 a	30700	t	89)	93
4808	60	3.62	107700	29700	"	1/3 a	30700	t	97)	
4809	100	5.02	103200	20600		1/2 a	23100	t	89)	
4810	100	4.96	103200	20700	"	1/2 a	23100	t	89)	89
4811	100	4.94	104600	21100	"	1/3 a	23100	t	91)	
4812	100	5.10	103800	20300	"	1/3 a	23100	t	88)	
4813	100	4.95	114200	23100	"	None	23100	None	100)	)100
4814	100	4.96	115000	23100	"	None	23100	None	100)	

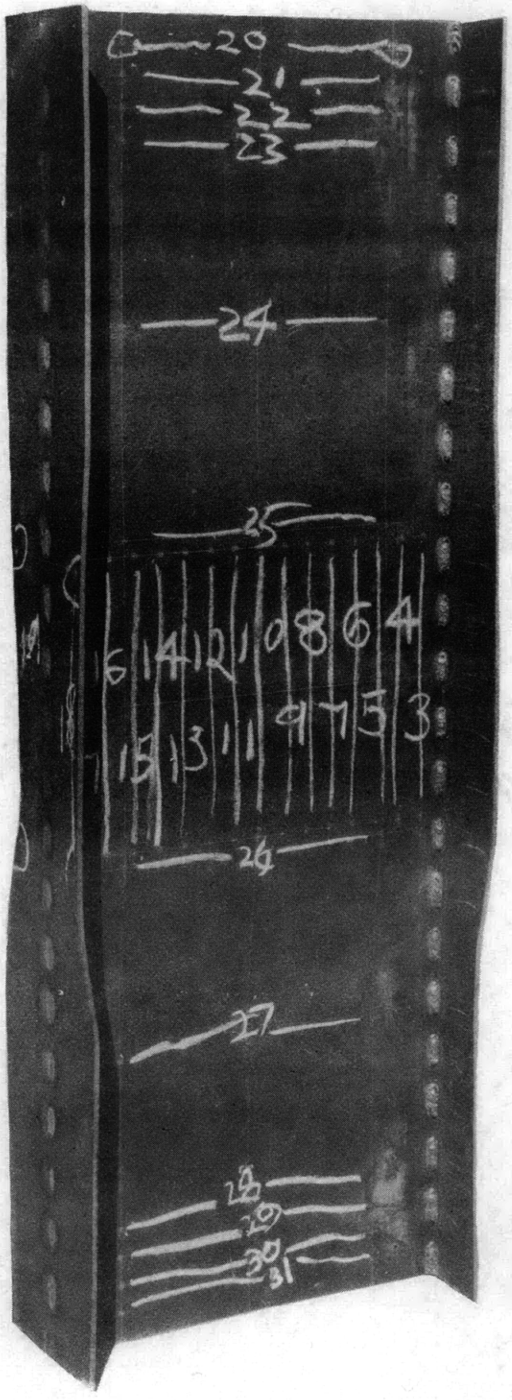
Yield Point = 41000 lbs/sq in.

E = 30×10^6 lbs/sq in.

t = 3/16" nominal

a = length

*This model had a 6" flange instead of 4 in.


20
21
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16 14 12 10 8 6 4
15 13 11 9 7 5 3
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31

FIG. 2

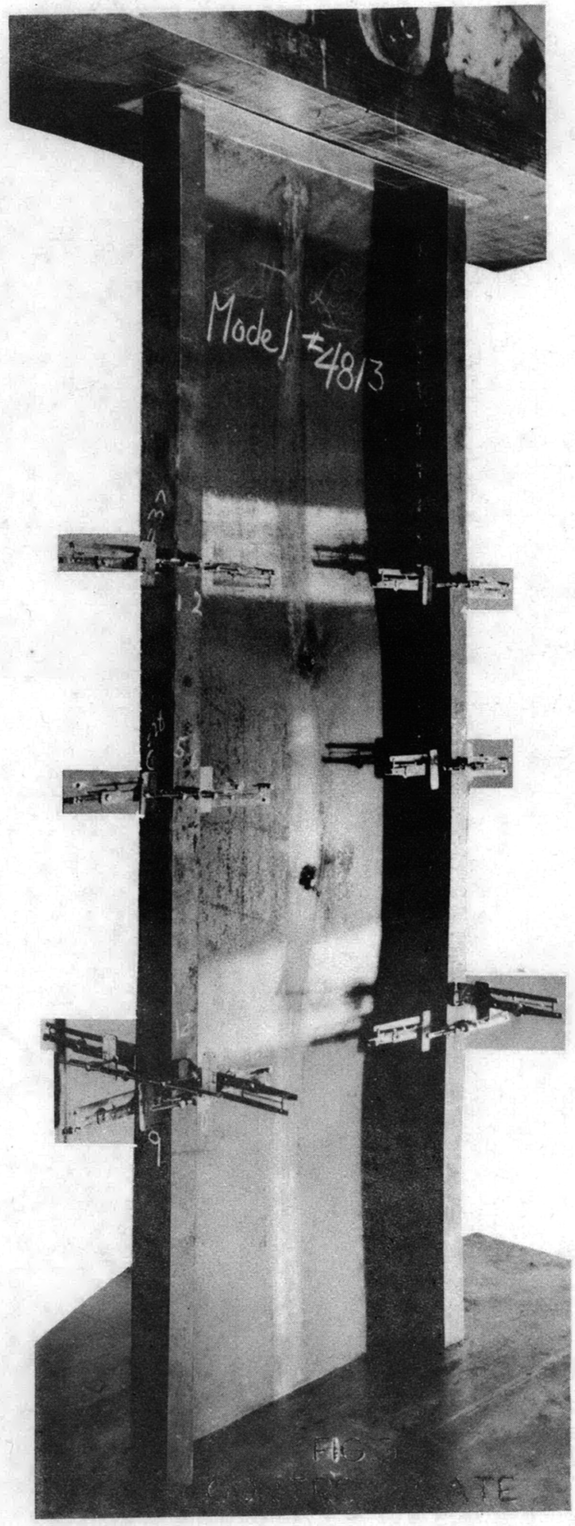
Model #4813

FIG. 3