Research on the test of CTOD specimen of short fatigue crack of Q370qE welded seam

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Abstract. This paper experimentally study the process and characteristics of the bridge structure steel CTOD specimens weld seam fatigue crack prefabricated. The results provide an experimental base and computing foundations for the bridge This paper studies the CTOD (Crack tip opening displacement) fatigue precracking experiment on steel Q370qE, which is of common use in bridge buildings. The experiment respectively tested Different thickness of Fatigue crack growth of Welded seam, whose results are analyzed, and the corresponding conclusions were studied.

Introduction

Due to the existence of natural inevitable defects in the structure, these defects, or is caused by the manufacturing process, or service that was caused by fatigue damage, but also may crack is caused by the impact load. The crack propagation and instability can cause the structural load bearing capacity and even total loss.This paper studies the CTOD (Crack tip opening displacement) fatigue precracking experiment on steel Q370qE, which is of common use in bridge buildings. The experiment respectively tested Different thickness of Fatigue crack growth of Welded seam, whose results are analyzed, and the corresponding conclusions are drawn..

Test materials

The using material --- Q370qE high-strength steel plate is produced by Wuhan iron and steel group. According to the British standard BS7448, prepare three points bending (TPB) standard sample.

Respectively Intercept 38mm and the 30mm test sample from bridge joist steel Q370qE(44mm and on the 36mm) as thickness B. the gap direction is thickness direction, and then Register the number of the sample group.

After finishing the front processing program, carefully buff the CTOD samples with sand paper with hand to make the surface more bright and smooth; Then clean the parts prepared to be cut and after that, confirm the position of the notch, mark the processing line according to British Code BS7448 and keep a record. Finally, process the CTOD samples by using cutting machine .After incision, the precision should be high, the cutting surface should be smooth and almost no distortion. During the process, the plane of crack must be perpendicular to the surface of the sample and the deviation be controlled within $\pm 2^0$,the deteriorative layer can be slowly wiped away with sand paper because it's thin. And then process the mechanical notch on cutting machine

by using molybdenum wire with the diameter not more than 0.1mm.

Experimental method

Prefabricated fatigue crack is required in all the standards of fracture toughness test at home and abroad, which aimed at obtaining the cracks that take place in the structure under the real simulation of natural conditions and it is the sharpest crack that can be obtained in laboratories. All the reinforced members in the experiment must use prefabricated fatigue crack that formed at room temperature on high frequency fatigue tester.

Throughout the whole experimental process, the fatigue crack of 2mm can be obtained firstly with low stress ratio R=0.1, then extends the crack to 5mm (concrete length is based on the experiment) with higher stress ratio R =0.6, and at the same time, make sure that the upper limit value of the maximum load of high frequency fatigue tester remains unchanged. Through this experimental method, it can be guaranteed that the crack tip stress will remain at low level and the evaluation result of fracture toughness CTOD will be more objective, true, and accurate.

Date process and results of fatigue crack experiments

The fatigue crack growth situations are shown in tab 1-1 and tab 1-2 according to the date acquisition system record of fatigue experiment machine.The fatigue crack growth of weld seam Q370qE bridge steel with different thickness

Tab 1-1 The fatigue crack growth of H44W

specimen number	specimen thickness (mm)	The minimum of the fatigue crack growth (mm)	The maximum of the fatigue crack growth (mm)	The average of the fatigue crack growth (mm)	The cycle number N (10^3)	Frequency (Hz)
H44W-1	38.00	4.911	5.480	5.050	66.0	119.9
H44W-2	38.00	4.220	5.250	5.110	71.1	112.7
H44W-3	37.95	4.540	5.140	5.040	67.6	117.6
H44W-4	38.10	4.650	5.580	5.210	64.3	116.6
H44W-5	38.08	4.750	5.080	5.030	65.3	115.6
H44W-6	38.02	4.120	5.860	5.250	63.6	117.4
H44W-7	37.98	4.200	5.480	5.110	67.1	113.4
H44W-8	38.08	3.990	5.170	4.890	70.5	110.6
H44W-9	38.15	4.170	5.060	5.000	63.5	115.4
H44w-10	38.06	4.550	5.580	5.270	68.6	117.6
H44W-11	38.02	4.290	5.670	4.780	86.0	117.1
H44W-12	38.00	4.770	5.420	5.290	69.3	112.0
Circulation average number N (10^3)			68.6			

Tab 1-2 The fatigue crack growth of H36W

specimen number	specimen thickness (mm)	The minimum of the fatigue crack growth (mm)	The maximum of the fatigue crack growth (mm)	The average of the fatigue crack growth (mm)	The cycle number N (10^3)	Frequency (Hz)
H36W-1	30.04	5.050	5.220	5.170	82.0	107.7
H36W-2	29.92	4.730	5.570	5.030	88.1	110.4
H36W-3	30.17	4.840	5.550	5.150	85.6	110.1
H36W-4	30.09	4.960	5.470	5.170	83.3	116.5
H36W-5	30.11	4.860	5.520	5.210	70.3	115.4
H36W-6	29.98	5.010	5.630	5.380	91.8	117.9
H36W-7	30.04	5.780	5.430	5.320	80.2	118.2
H36W-8	30.07	5.060	5.400	5.270	79.5	118.7
H36W-9	30.04	4.750	5.610	5.310	73.8	115.4
H36W-10	30.05	4.980	5.210	5.110	77.6	117.5
H36W-11	30.26	4.770	5.050	5.020	86.8	117.1
H36W-12	30.00	4.840	5.820	5.390	74.2	117.1
Circulation average number N (10^3)			81.1			

From table 1-1, 1-2 can see, different thickness of the bridge of q370qe steel weld fatigue crack propagation, the plate thickness is 38mm component of crack growth rate than the plate thickness of 30mm component to. The reason is due to the constraints along the thickness direction of plate specimen is not prone to plastic deformation, resulting in growth rate is fast.

Conclusion

According to the test purpose and test the actual situation, in accordance with the metal material fracture toughness CTOD test specification, all specimens were fatigue pre crack, its purpose is in test chamber to get the real simulation of natural the sharp crack. The fatigue crack of all specimens was carried out at room temperature under the condition of normal temperature, and the crack propagation length and the number of cycles were obtained.. For thick plate, due to the surface and internal heat and heat during welding, the thermal stress caused by the surface of the member and the inner surface of the member, which cause the effect of the material to resist fatigue load..

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