HYDROGENIUS
水素材料先端科学研究センター

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HYDROGENIUS DATABASE

— Fatigue Properties —

No. C54

Database of Fatigue-Strength Properties of Hydrogen-Charged JIS-SUS304 (Type 304) Austenitic Stainless Steel in Air

2017

Research Center for Hydrogen Industrial Use and Storage (HYDROGENIUS)
Kyushu University - JAPAN
National Institute for Materials Science (NIMS)
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1. MATERIALS

Table 1. Details of processing and related data of SUS304.

Heat	Production Process	Product Format	Dimensions (mm)
D[1)]	Hot-rolled	Round bar	Diameter: 20 mm
V[1)]	Hot-rolled	Plate	Length: 7000 mm, Width: 3100 mm Thickness: 30 mm

[1)] As reported by the manufacturer.

Table 2. Chemical composition of SUS304.

	Heat		Element (mass%)						
			C	Si	Mn	P	S	Ni	Cr
Product Analysis	D[1)]		0.05	0.27	1.31	0.035	0.028	8.10	18.60
	V[2)]		0.04	0.53	1.32	0.025	0.002	8.15	18.70
Ladle Analysis	D[3)]		0.06	0.50	1.47	0.031	0.024	8.15	18.31
	V[3)]		0.04	0.57	1.22	0.023	0.002	8.09	18.15
	Requirements[4)]	Max.	0.08	1.00	2.00	0.045	0.030	10.50	20.00
		Min.						8.00	18.00

[1)] As performed by HYDROGENIUS.
[2)] As performed by NIMS.
[3)] As reported by the manufacturer.
[4)] As per JIS G 4303:2012, *"Stainless Steel Bars"*, and JIS G 4304:2005, *"Hot-rolled Stainless Steel Plate, Sheet and Strip"*.

Table 3. Heat-treatment conditions of SUS304.

Heat	Heat-treatment	Conditions
D[1)]	Solution-treatment	1050°C, 2 min, water-quenching
V[1)]	Solution-treatment	1080°C, 3 min, water-cooling

[1)] As reported by the manufacturer.

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No. 38, Tables 1, 2, 3 and 4.

2. MECHANICAL PROPERTIES

Table 4. Mechanical properties of SUS304.

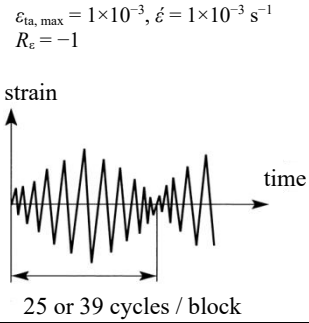
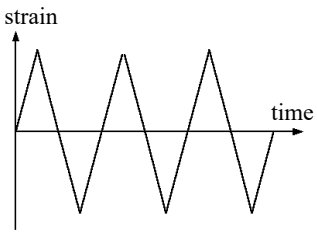
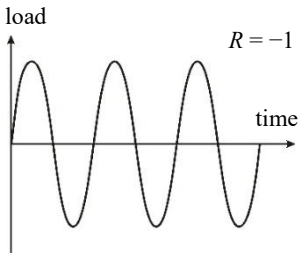
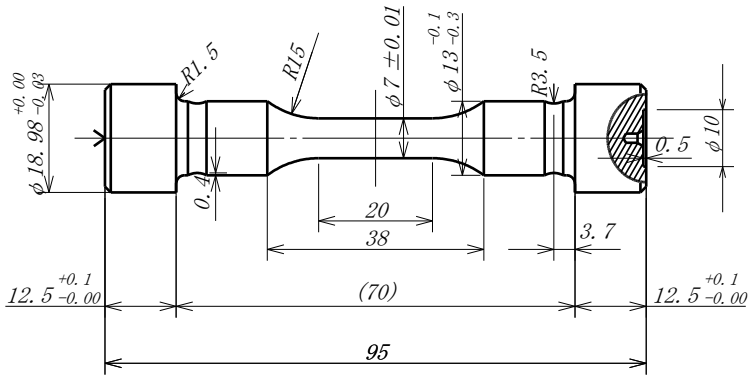
Heat		Tensile Properties				Vickers Hardness (*HV*)
		0.2% Proof Stress, $\sigma_{0.2}$ (MPa)	Tensile Strength, σ_B (MPa)	Elongation, ε_f (%)	Reduction of Area, φ (%)	
D[1)]		279	630	57	75	
V[1)]		276	658	63		
Requirements[2)]	Max.					200
	Min.	205	520	40	60	

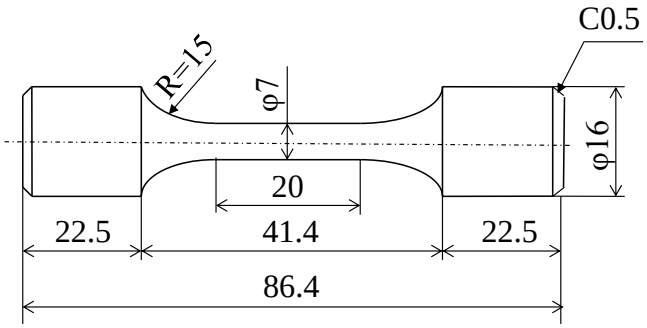
[1)] As reported by the manufacturer.
[2)] As per JIS G 4303:2012, *"Stainless Steel Bars"* and JIS G 4304:2005, *"Hot-rolled Stainless Steel Plate, Sheet and Strip"*.

It should be noted that the following data are identical to those featured in HYDROGENIUS DATABASE No. 38, Tables 1, 2, 3 and 4.

3. FATIGUE-STRENGTH PROPERTIES

Table 5. Fatigue-test conditions.

<table>
<tr><td>Type of test</td><td colspan="3">Uniaxial</td></tr>
<tr><td>Testing machine</td><td colspan="3">50 kN, servo-hydraulic fatigue machine</td></tr>
<tr><td>Loading conditions</td><td>Incremental step-test</td><td>Constant strain amplitude test</td><td>Constant stress amplitude test</td></tr>
<tr><td rowspan="2">Waveforms</td><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td colspan="2">Triangular</td><td>Sinusoidal</td></tr>
<tr><td>Strain rate or frequency</td><td colspan="2">1×10^{-3} s^{-1}, 5×10^{-3} s^{-1}</td><td>0.01 ~ 1 Hz</td></tr>
<tr><td>Environment</td><td colspan="3">Laboratory air, RT</td></tr>
<tr><td>Specimens[1)]</td><td colspan="3"> 

(a) Type-A


(b) Type-B</td></tr>
</table>

[1)] The specimen surface was finished by buffing, using a colloidal SiO_2 (0.04 μm) solution.

Table 6. Conditions of hydrogen-charging.

Hydrogen exposure	Exposure to hydrogen gas at pressures of 10 MPa, 40 MPa, 68 MPa or 100 MPa, at a temperature of 270°C or 300°C
Hydrogen-gas purity	99.999% (5N)
Holding time	245 h or 400 h

Table 7. Hydrogen-measurement conditions of fractured fatigue specimens.

Specimen shape	Disk with a diameter of 7 mm and a height of 10 mm, cut from a fractured fatigue specimen
Type of hydrogen measurement	Thermal desorption analysis, TDA
Heating rate	100°C/min
Hydrogen-detection accuracy	0.3 Vol. ppm