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Article:

Brevis, W., Susmel, L. and Boxall, J.B. (2014) Investigating in-service failures of water pipes from a multiaxial notch fatigue point of view: A conceptual study. Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science.. ISSN 0954-4062

https://doi.org/10.1177/0954406214553020

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- **Table 2:** Results of the sensitivity analysis in the presence of pitting (CA=constant amplitude solution; VA=variable amplitude solution). An FDI index equal to 0% indicates a fatigue situation equivalent to the reference case, a negative index indicates a more damaging case and a positive index a less damaging case. N.B. Normal in-service internal pressure is typically in the range 0.35-1 MPa, so that pi was intentionally taken equal to 6 MPa to make the sensitivity analysis much easier to be interpreted.
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	n				*		~	~	τ.	FDI		Type of
Case	P 1,a	Ri	p _{e,a} / p _{i,a}	Re	Ψр	f_i/f_e	Ob	Oax	۰t	@ r _i	@ r _e	Fatigue
	[MPa]				[°]		[MPa]	[MPa]	[MPa]	[%]	[%]	Analysis
Reference	6	0.1								0.0	24.0	CA
	6	0.1	1	0.1	0	1				267.2	267.2	CA
	6	0.1	1	0.1	0	10				-1.5	5.0	VA
	6	0.1	1	0.1	0	100				11.1	17.6	VA
	6	0.1	1	0.1	0	0.1				-1.5	5.0	VA
	6	0.1	1	0.1	0	0.01				11.1	17.6	VA
	6	0.1	2	0.1	0	1				40.6	58.7	CA
	6	0.1	2	0.1	0	10				-18.6	-8.5	VA
А	6	0.1	2	0.1	0	100				-6.1	4.0	VA
	6	0.1	2	0.1	0	0.1				-19.1	-8.9	VA
	6	0.1	2	0.1	0	0.01				-9.5	1.7	VA
	6	0.1	0.5	0.1	0	1				87.5	103.4	CA
	6	0.1	0.5	0.1	0	10				7.4	3.0	VA
	6	0.1	0.5	0.1	0	100				19.0	15.2	VA
	6	0.1	0.5	0.1	0	0.1				7.8	3.4	VA
	6	0.1	0.5	0.1	0	0.01				20.2	15.7	VA
	6	0.1	1	0.1	90	1				10.8	20.7	CA
	6	0.1	1	0.1	90	10				-1.5	5.0	VA
	6	0.1	1	0.1	90	0.1				-1.1	5.5	VA
	6	0.1	2	0.1	90	1				-12.8	-0.7	CA
В	6	0.1	2	0.1	90	10				-18.7	-8.6	VA
	6	0.1	2	0.1	90	0.1				-18.9	-8.7	VA
	6	0.1	0.5	0.1	90	1				18.5	17.7	CA
	6	0.1	0.5	0.1	90	10				7.4	2.9	VA
	6	0.1	0.5	0.1	90	0.1				8.5	2.9	VA
	6	0.1					50			0.0	24.0	CA
	6	0.1					120			0.0	24.0	CA
C	6	0.1					-50			0.0	24.0	CA
	6	0.1					-120			0.0	24.0	CA
	6	0.1						50		0.0	24.0	CA
D	6	0.1						120		0.0	24.0	CA
D	6	0.1						-50		0.0	24.0	CA
	6	0.1						-120		0.0	24.0	CA
Б	6	0.1							50	0.0	24.0	CA
E	6	0.1							120	0.0	24.0	CA
	6	0.1	1	0.1	0	100	50	50	50	11.1	17.6	VA
	6	0.1	1	0.1	0	0.01	50	50	50	11.1	17.6	VA
Б	6	0.1	2	0.1	0	100	50	50	50	-6.1	4.0	VA
Г	6	0.1	2	0.1	0	0.01	50	50	50	-9.5	1.7	VA
	6	0.1	0.5	0.1	0	100	50	50	50	19.0	15.2	VA
	6	0.1	0.5	0.1	0	0.01	50	50	50	20.2	15.7	VA

Tables

Table 1: Results of the sensitivity analysis in the absence of pitting (CA=constant amplitude solution; VA=variable amplitude solution). An FDI index equal to 0% indicates a fatigue situation equivalent to the reference case, a negative index indicates a more damaging case and a positive index a less damaging case. N.B. Normal in-service internal pressure is typically in the range 0.35-1 MPa, so that p_i was intentionally taken equal to 6 MPa to make the sensitivity analysis much easier to be interpreted.

Case	р і,а [<i>МРа</i>]	Ri	p _{e,a} / p _{i,a}	Re	ф _Р /°1	f _i /f _e	FDI @ r _e [%]	Type of Fatigue Analysis
	6	0.1	1	0.1	0	100	-18.9	VA
	6	0.1	1	0.1	0	1	129.1	CA
	6	0.1	1	0.1	90	1	-26.2	CA
	6	0.1	1	0.1	0	0.01	-18.9	VA
	6	0.1	2	0.1	0	100	-26.6	VA
G	6	0.1	2	0.1	0	1	-0.1	CA
U	6	0.1	2	0.1	90	1	-39.3	CA
	6	0.1	2	0.1	0	0.01	-35.3	VA
	6	0.1	0.5	0.1	0	100	-19.7	VA
	6	0.1	0.5	0.1	0	1	24.2	CA
	6	0.1	0.5	0.1	90	1	-23.6	CA
	6	0.1	0.5	0.1	0	0.01	-14.9	VA

Table 2: Results of the sensitivity analysis in the presence of pitting (CA=constant amplitude solution; VA=variable amplitude solution). An FDI index equal to 0% indicates a fatigue situation equivalent to the reference case, a negative index indicates a more damaging case and a positive index a less damaging case. N.B. Normal in-service internal pressure is typically in the range 0.35-1 MPa, so that pi was intentionally taken equal to 6 MPa to make the sensitivity analysis much easier to be interpreted.

	Units	Case A	Case B	Case C	Case D	Case E	Case F	Case G	Case H	Case I	Case K
Nominal Size		6" Class A	6" Class A	6" Class A	6" Class A	6" Class A	6" Class A	3" Class A	3" Class A	15" Class A	15" Class A
De	[m m]	177.3	177.3	177.3	177.3	177.3	177.3	95.5	95.5	413.0	413.0
t	[m m]	10.9	10.9	10.9	10.9	10.9	10.9	9.7	9.7	15.0	15.0
а	[mm/year]	0.021	0.021	0.021	0.0336	0.021	0.021	0.021	0.0336	0.021	0.0336
k	[m m]	9.75	9.75	9.75	15.6	9.75	9.75	9.75	15.6	9.75	15.6
с	[year-1]	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Pit's Geometry		Hyperbolic	Hemispherical	Hyperbolic	Hyperbolic						
Kt		3.4	2.23	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
p _{i,max}	[MPa]	1.8	1.8	1.8	1.8	1	1	1.8	1	1.8	1
Ri		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
p _i (t) Spectrum		pi_CUS	pi_CUS	p_i_CDS	pi_CDS	pi_CUS	p_i_CUS	pi_CUS	p_i_CUS	pi_CUS	p_i_CUS
p e,max	[MPa]	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5
Re		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
p _e (t) Spectrum		Road_SP	Road_SP	Road_SP	Road_SP	Road_SP	Road_SP	Road_SP	Road_SP	Road_SP	Road_SP

Table 3: Situations of practical interest used to investigate the way the Total Fatigue Damage, D_{tot}, increases over time when it is estimated according to the proposed methodology.

Figures



Figure 1: Pit in the wall of a pipe and its schematisation through a hemispherical and hyperbolic notch (a); pit depth vs. time according to Rajani's exponential law [L18] (b); fatigue strength reduction factor vs. pit tip radius estimated for grey cast iron with flake graphite according to Heywood [L22] (c).

















Figure 2: Structural schematisations adopted to perform the stress analysis.



(a)



Figure 3: Uniaxial (a) and torsional (b) fully-reversed plain and notch fatigue curves.



Figure 4: In-field use of the MWCM.



Figure 5: Proposed methodology to estimate the fatigue damage, D_{y-i}, associated with the i-th year of service.

Figure 6: Adopted load spectra summarising the number of significant events per day.

Please cite this article as: **Brevis**, **W.**, **Susmel**, **L.** and **Boxall J. B.** (2014) *Investigating in-service failures of* water pipes from a multiaxial notch fatigue point of view: A conceptual study. Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science. DOI: 10.1177/0954406214553020

Figure 7: Total Fatigue Damage evolution over time for the situations described in Table 3.