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A method for corrosion-fatigue life prediction

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A METHOD FOR

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CORROSION - FATIGUE LIFE

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PREDICTION

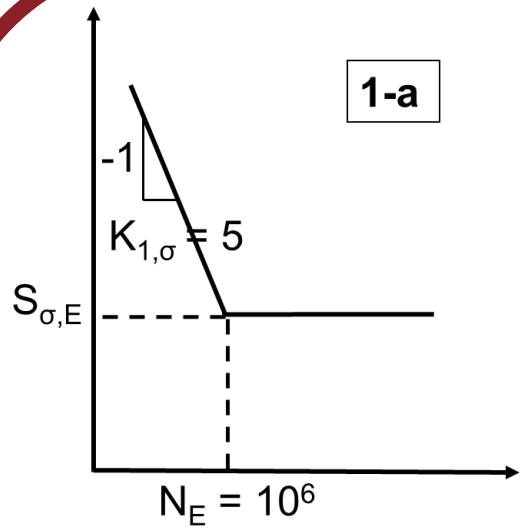
Mechanical and Aerospace Engineering

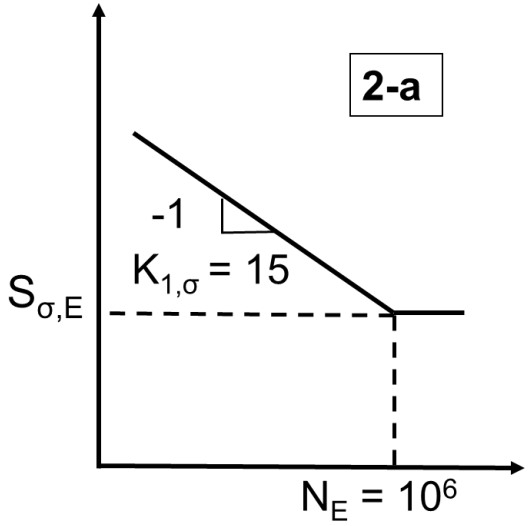
ABSTRACT

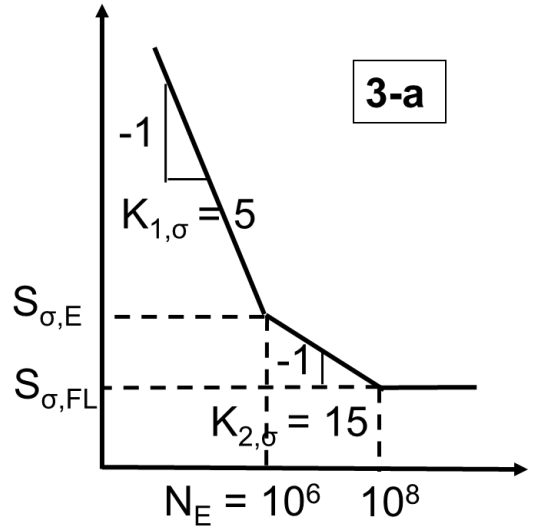
This paper presents a method and strategy to predict/estimate fatigue life in terms of S-N curves for different material/environment systems. It is proposed that in dry air environment the stress amplitude corresponding to the endurance limit at $2N_f = 2x10^6$ and an intermediate life of $2N_f = 2x10^3$ reversals can be estimated from the ultimate strength, σ_u. The proposed method is compare with the well-established German FKM method. For corrosion-fatigue the proposed strategy requires the S-N curve in air and the corresponding k_{corr} factor at the endurance limit. Experimental data for selected steel, aluminum, and titanium alloys are used to illustrate and validate the proposed methodology. A fairly good agreement is demonstrated for vacuum, air and 3.5% NaCl environments.

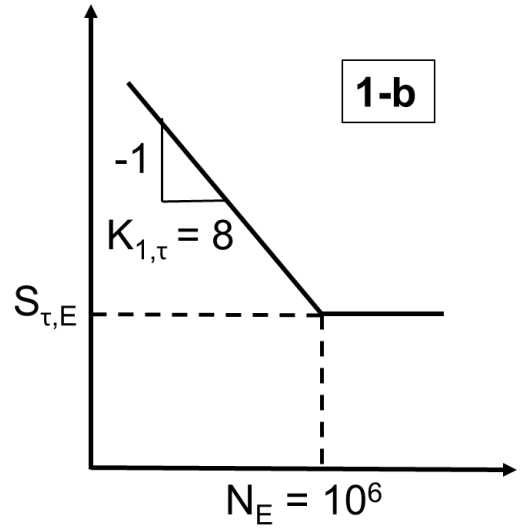
GERMAN FKM GUIDELINE

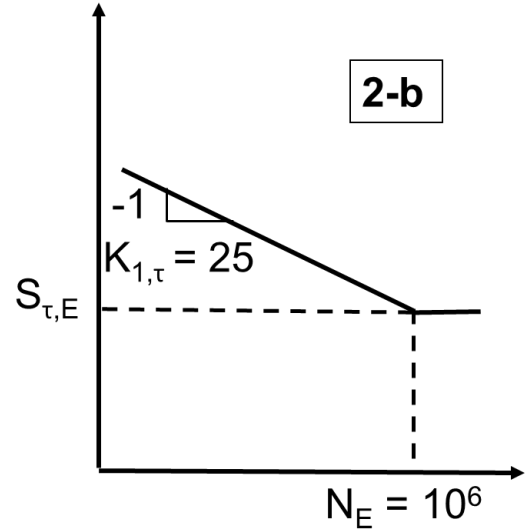
Endurance Limit Factor For Various Materials	
Material Type	**$C_{\sigma,E}$**
Case Hardening Steel	0.4
Stainless Steel	0.4
Forging Steel	0.4
Steel Casting	0.34
Other Types of Steel	0.45
Ductile Iron	0.34
Malleable Cast Iron	0.30
Gray Cast Iron	0.30
Wrought Aluminum Alloys	0.30
Cast Aluminum Alloys	0.30

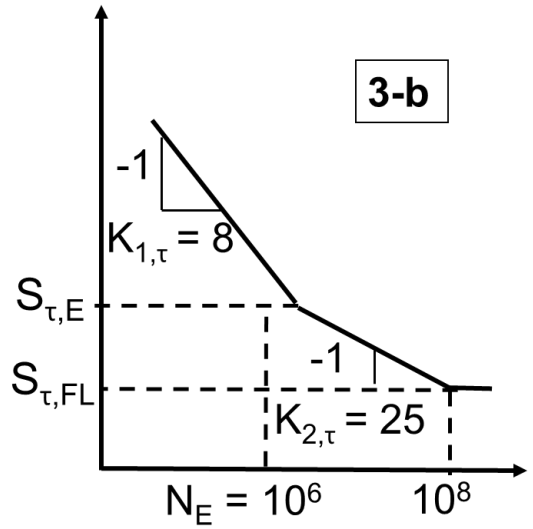












1) Surface non-hardened components made of steels and cast irons

2) Surface hardened components made of steels and cast irons

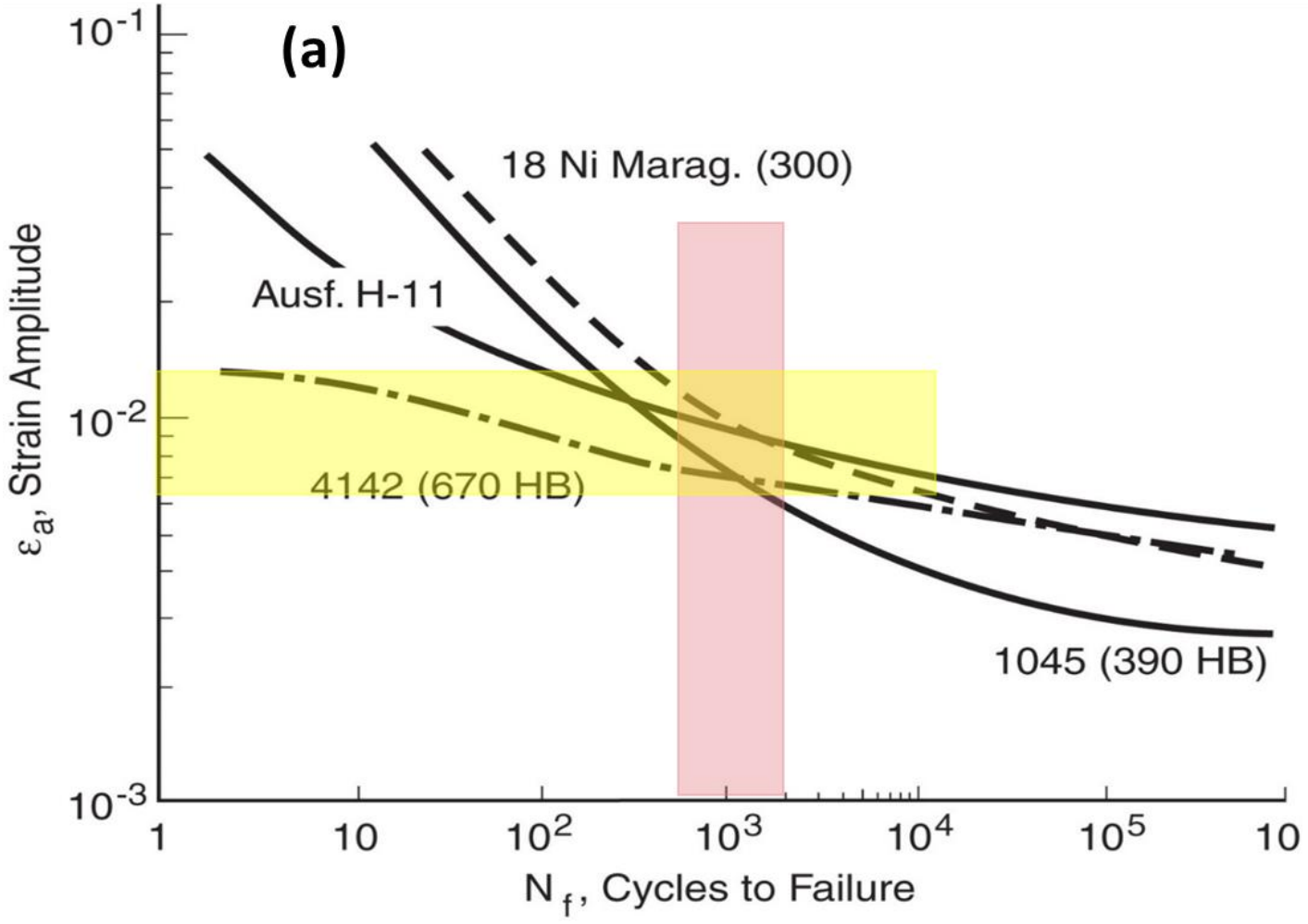
3) Components made of aluminum alloys and austenitic steels

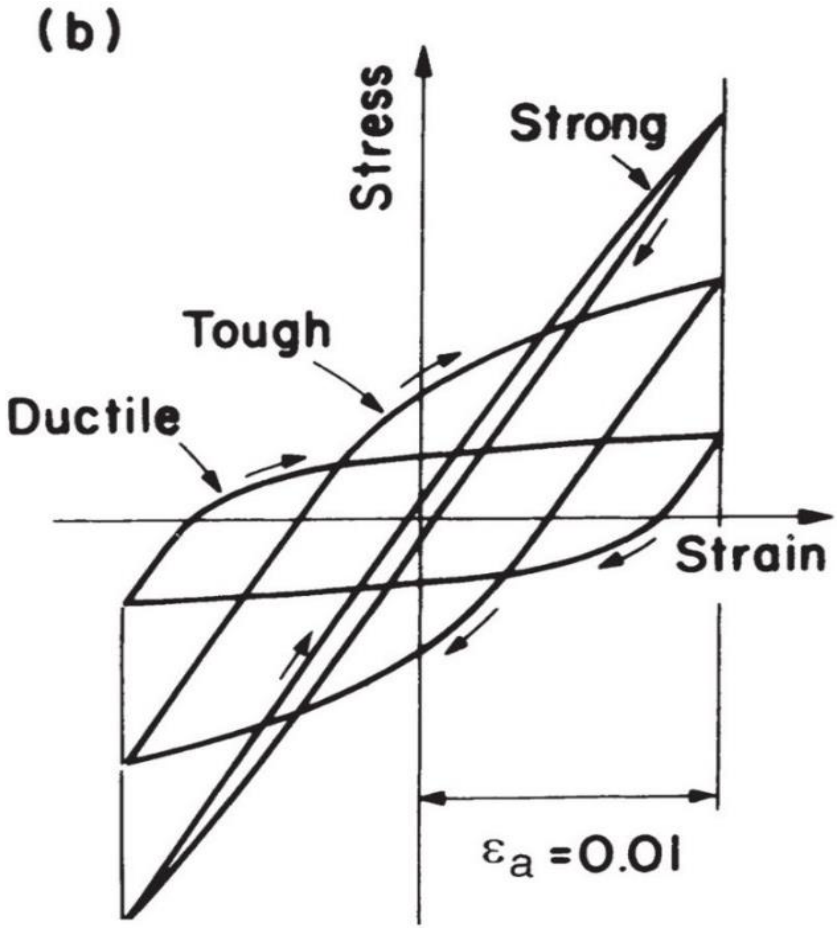
Synthetic Components
Constant Amplitude S-N Curves for Different Materials

TRENDS IN STRAIN-LIFE CURVES

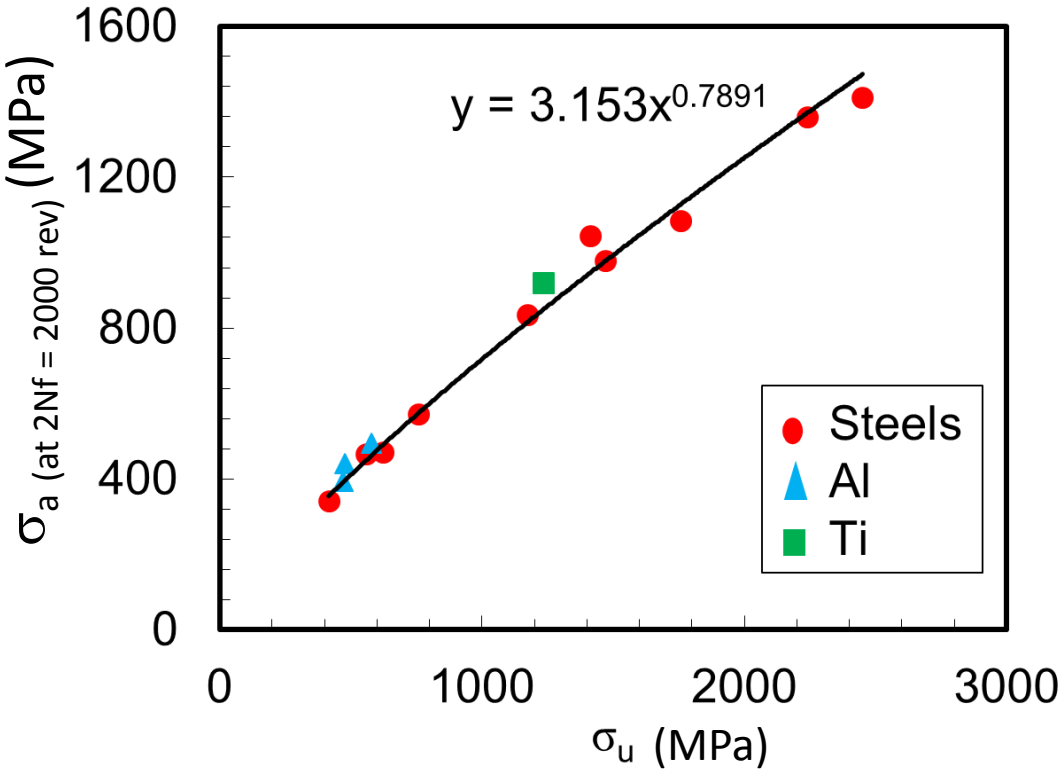
for strong, tough, and ductile materials

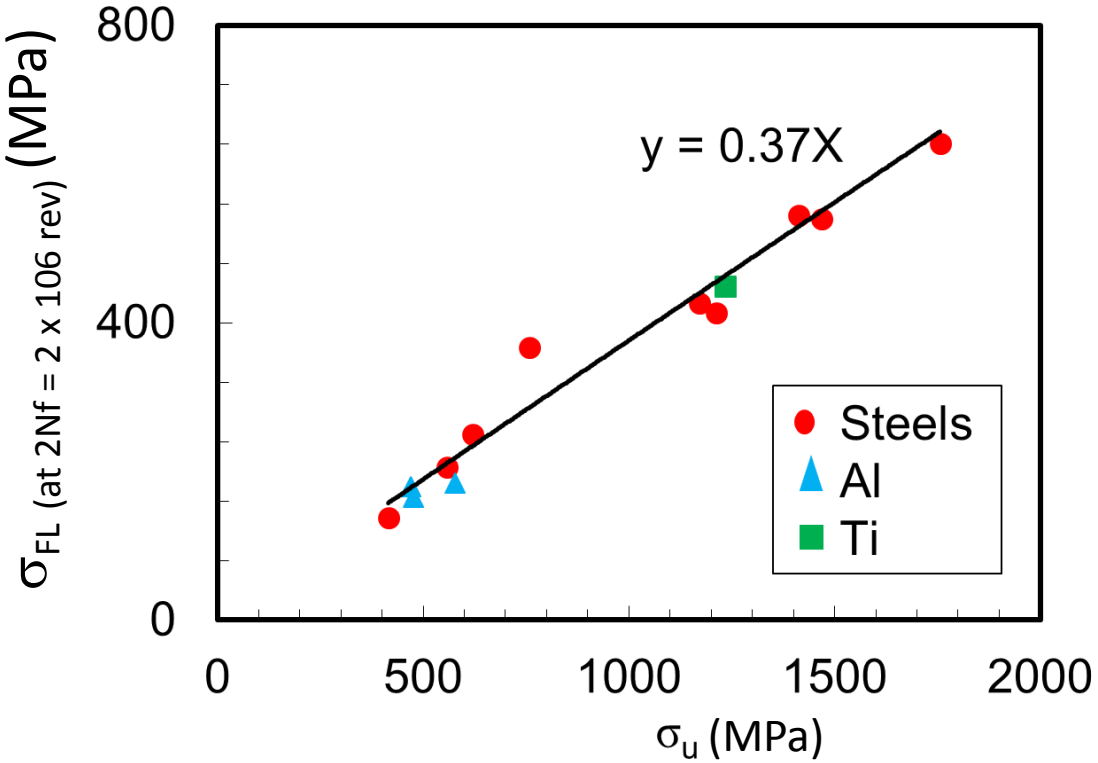
Landgraf (1970) (Adopted from Dowling book)



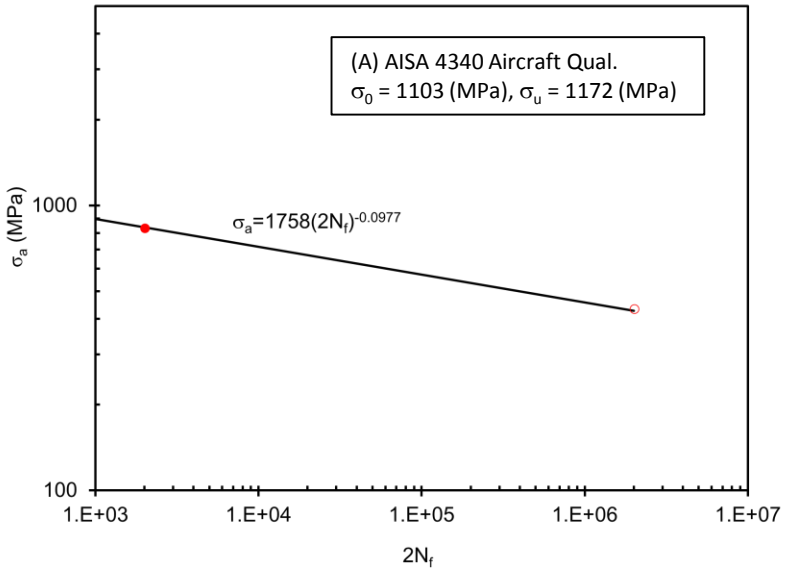


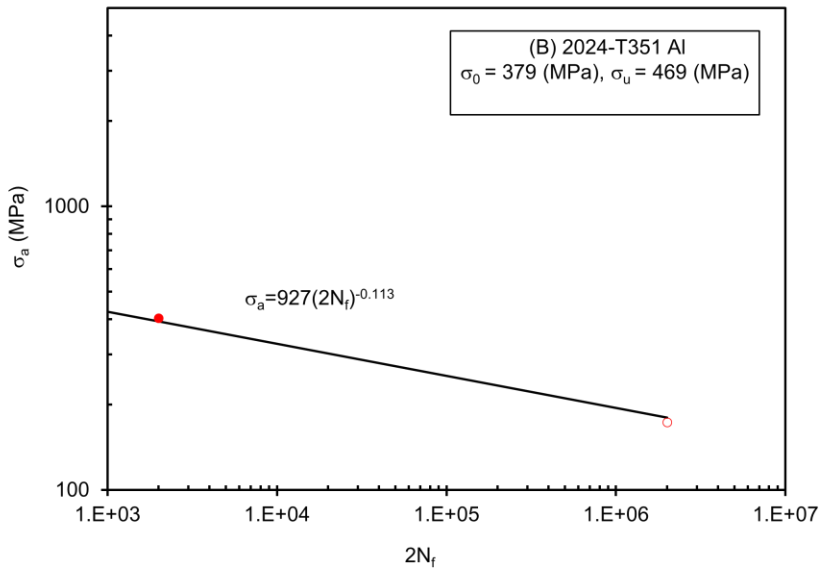
PROPOSED APPROACH

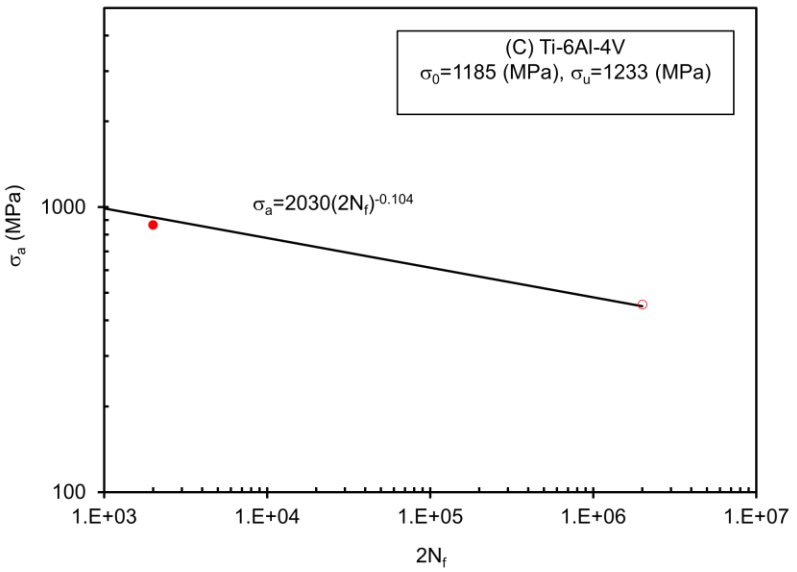




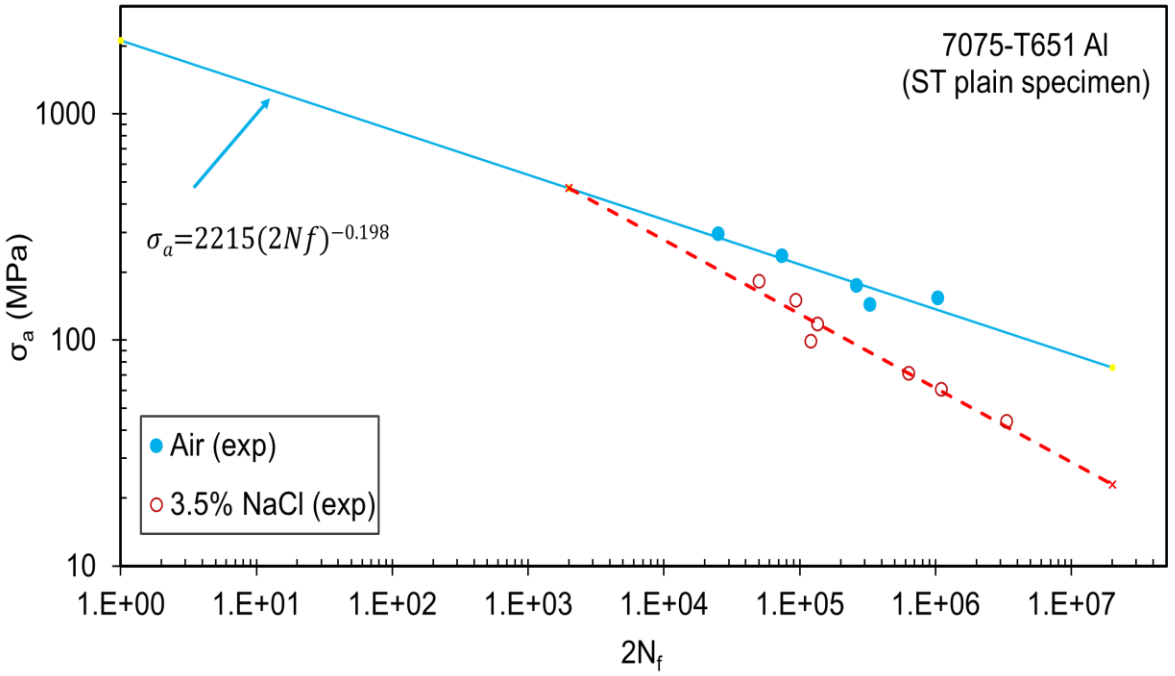
ESTIMATED S-N CURVE FOR THREE DIFFERENT TYPES OF MATERIAL

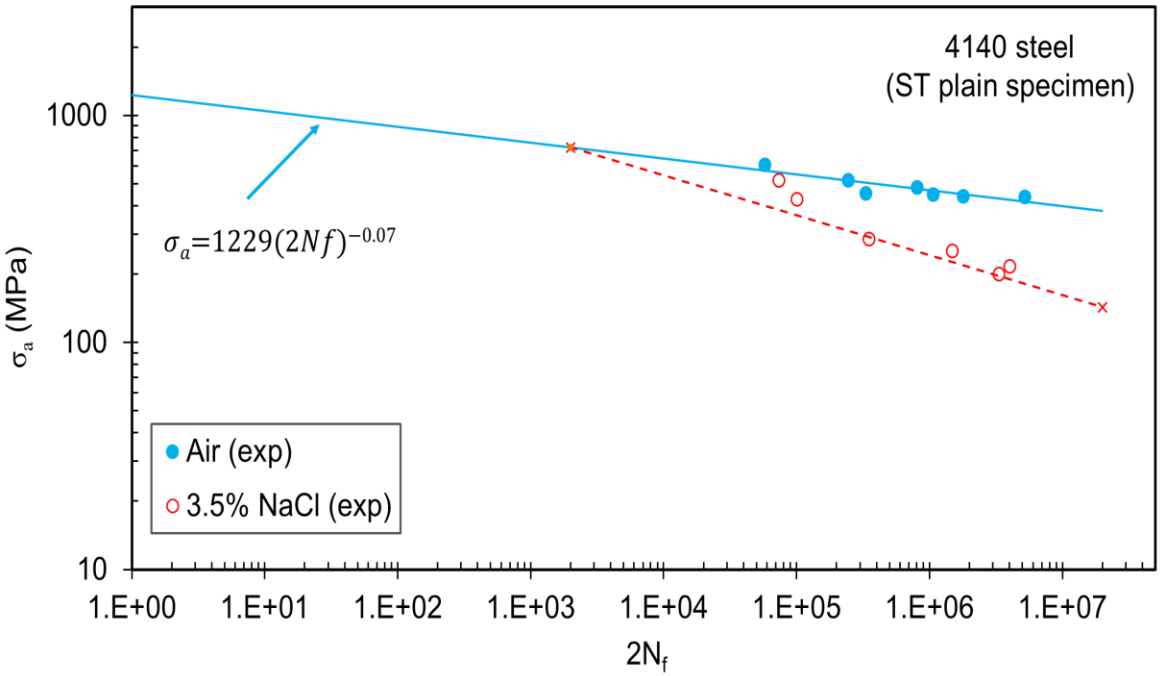


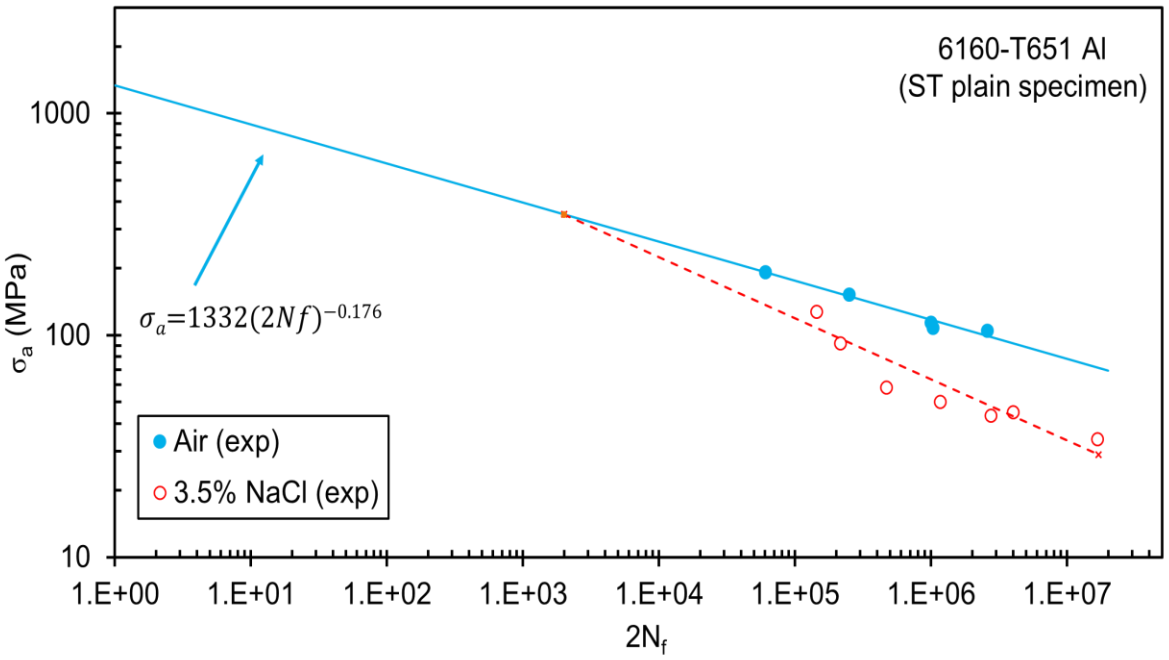


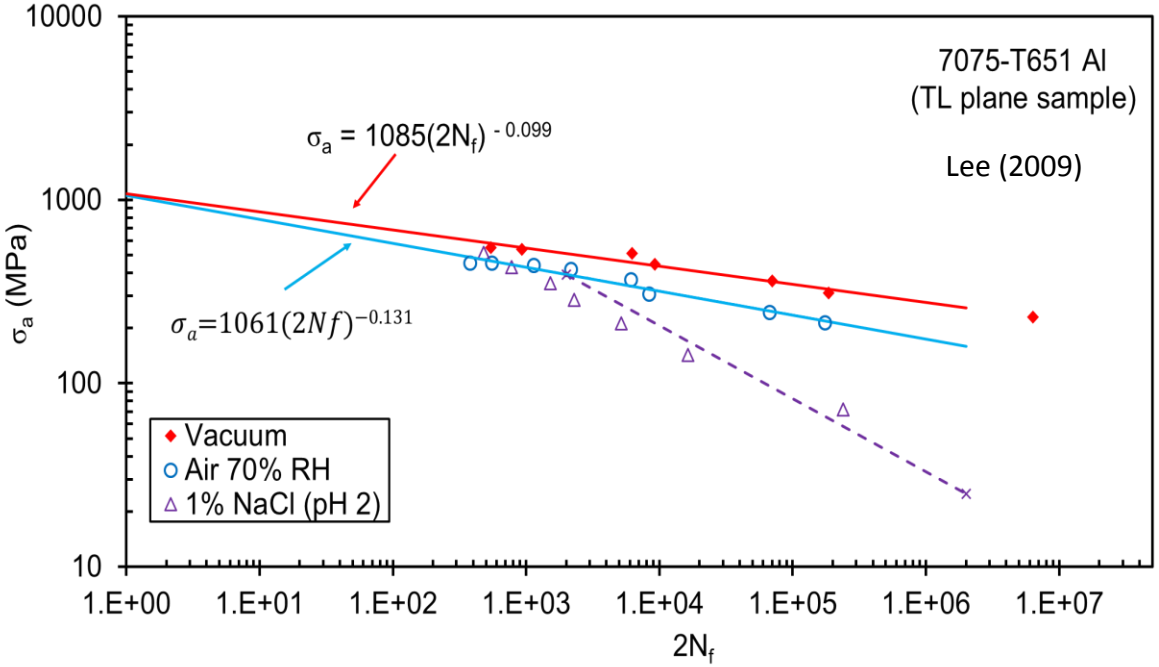


S-N CURVE OF DIFFERENT ENVIRONMENT

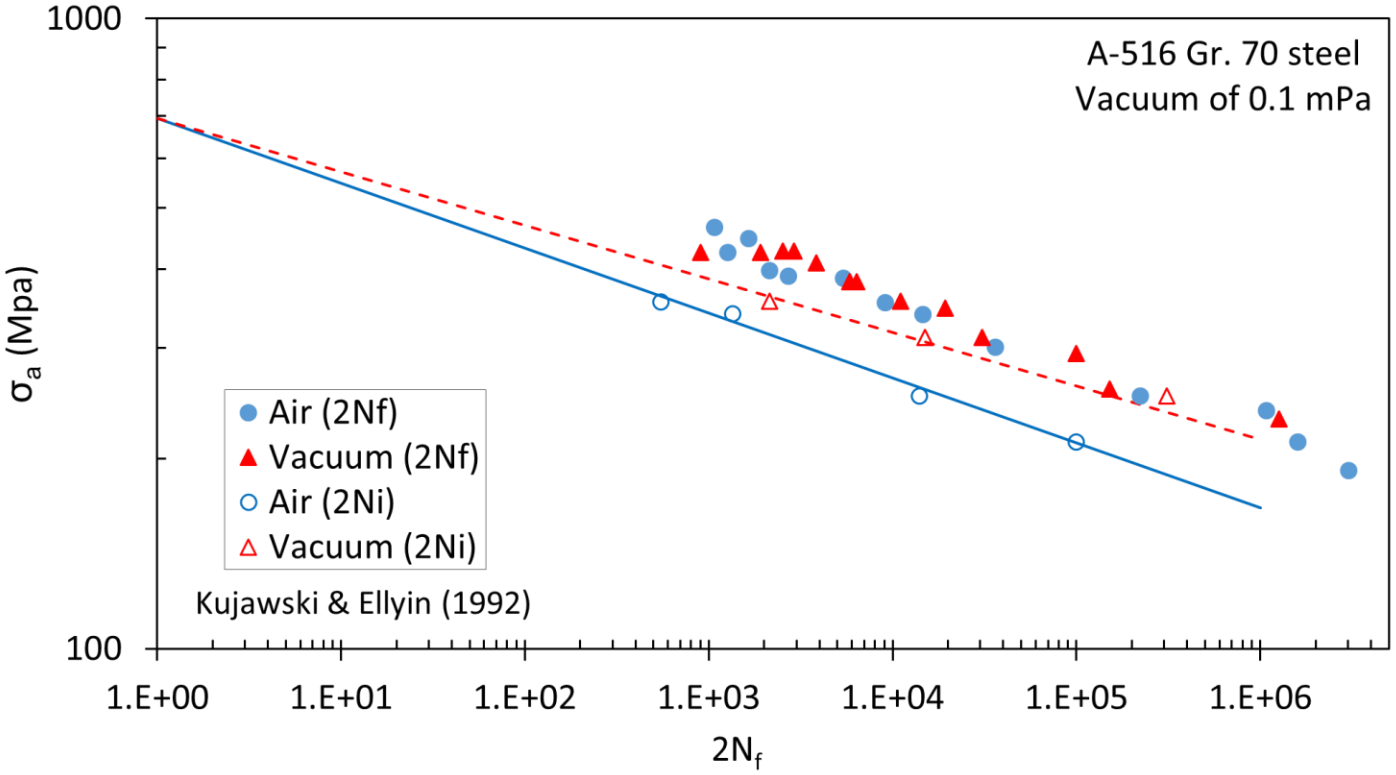





6160-T651 Al
(ST plain specimen)
σ_a=1332$(2Nf)^{-0.176}$
Air (exp)
3.5% NaCl (exp)
σ_a (MPa)
1000
100
10
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
1.E+07
$2N_f$


7075-T651 Al
(TL plane sample)
Lee (2009)
$\sigma_a = 1085(2N_f)^{-0.099}$
σ_a=1061$(2Nf)^{-0.131}$
Vacuum
Air 70% RH
1% NaCl (pH 2)
σ_a (MPa)
10000
1000
100
10
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
1.E+07
$2N_f$

CRACK INITIATION AND TOTAL FATIGUE LIFE IN VACUUM AND AIR



CONCLUSION :

1. A strategy to predict fatigue life in terms of S-N curves for different material/environment systems has been proposed.
2. A fairly good agreement is demonstrated for vacuum, air and NaCl environments.

ACKNOWLEDGMENT :

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