

RELIABLE OPTIMAL USE OF MATERIALS FOR WIND TURBINE ROTOR BLADES



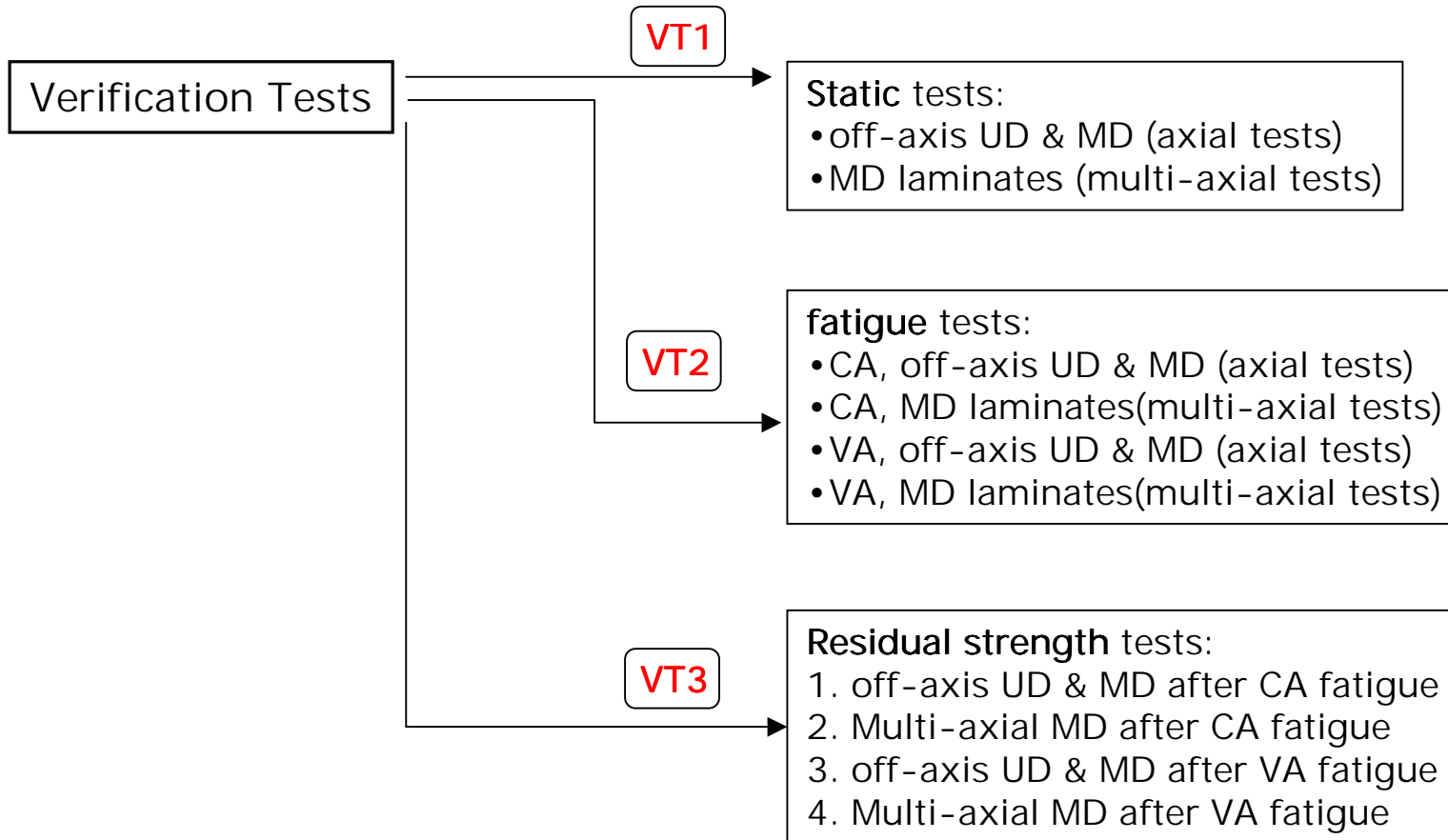
OPTIMAT BLADES

(ENK6-CT-2001-00552)

Verification test program. UD off-axis and MD specimens

TASK GROUP 2: Investigation of blade material behavior
under complex stress states

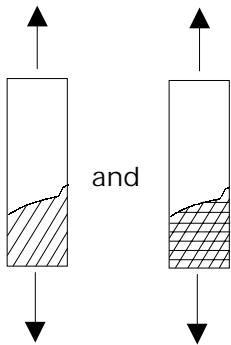
Theodore P. Philippidis, April 2002
University of Patras, Dept. of Mechanical Engineering & Aeronautics





VT1. Verification tests for static strength

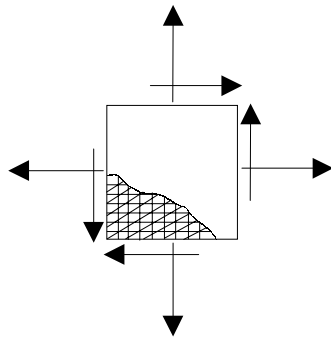
VT1.1 off-axis UD & MD (axial tests)



At 2 different off-axis orientations, e.g. 10° and 60° , 6 coupons (3T+3C),
2 different laminates (UD and MD) = **24 coupons**

Time schedule: 1 week (24 coupons)

VT1.2 MD laminates (multi-axial tests)



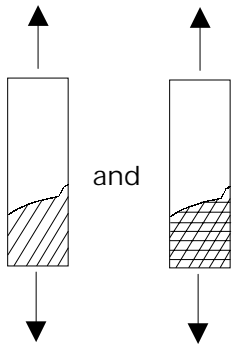
At 2 different complex stress states (pressure and suction representative)
5 specimens from MD laminates = **10 specimens**

Time schedule: 2 weeks (10 specimens)



VT2. Verification tests for fatigue strength

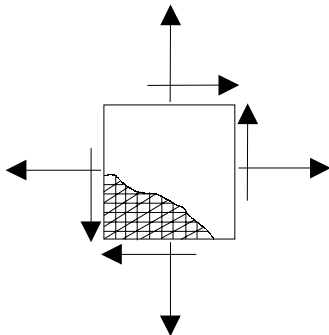
VT2.1 CA off-axis UD & MD (axial tests)



At 2 different off-axis orientations, e.g. 10° and 60° , 5 coupons, 2 different Laminates, high (10^6) and low (10^3) cycle fatigue (different stress ratios can be used for UD and MD laminates) = **40 coupons**

Time schedule: 3 months (40 coupons)

VT2.2 CA MD laminates (multi-axial tests)



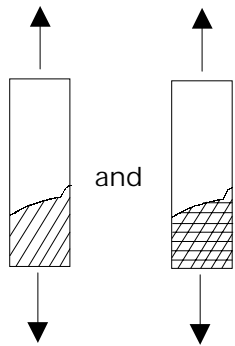
At 2 different complex stress states (pressure and suction representative) 5 specimens from MD laminates, high (10^6) and low (10^3) cycle fatigue = **20 specimens**

Time schedule: 2 months (20 specimens)



VT2. Verification tests for fatigue strength

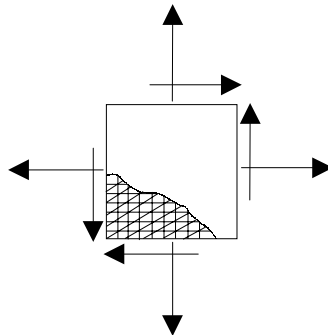
VT2.3 VA off-axis UD & MD (axial tests)



At 2 different off-axis orientations, e.g. 10° and 60° , 5 coupons, 2 different laminates (UD and MD), under VA loading = **20 coupons**

Time schedule: 2 months (20 coupons)

VT2.4 VA MD laminates (multi-axial tests)



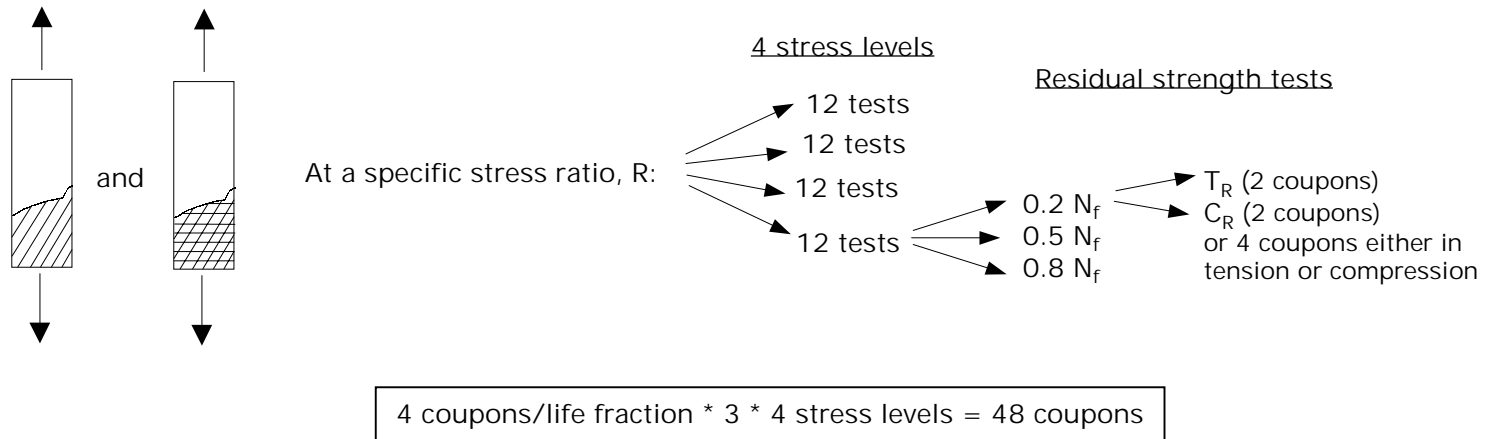
At 2 different complex stress states (pressure and suction representative) 5 specimens from MD laminates, VA loading = **10 specimens**

Time schedule: 1 month (10 specimens)



VT3. Verification tests for residual strength

VT3.1 off-axis UD & MD after CA fatigue

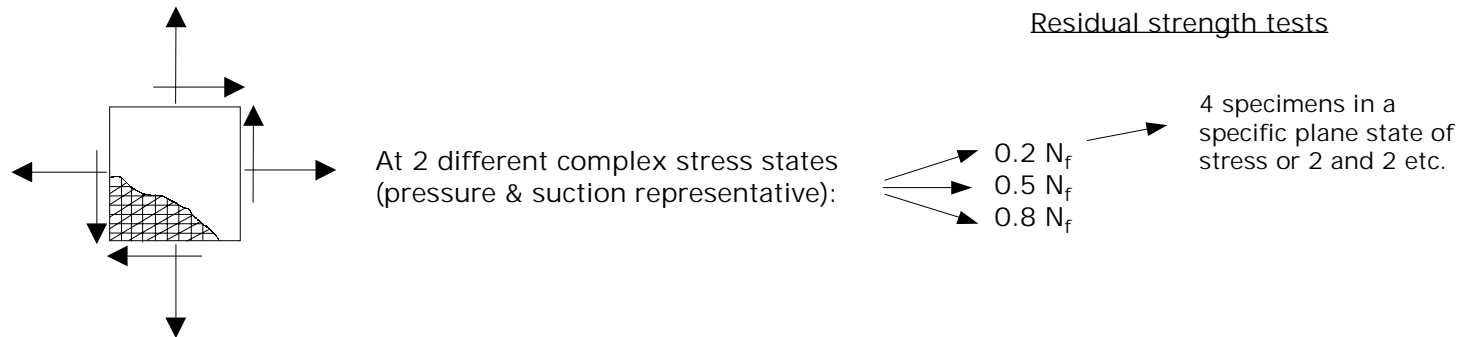


Time schedule: 1.2 months for 48 coupons. Therefore, 1.2 months * 2 (UD, MD) = 2.4 months (96 coupons)



VT3. Verification tests for residual strength

VT3.2 multi-axial MD after CA fatigue



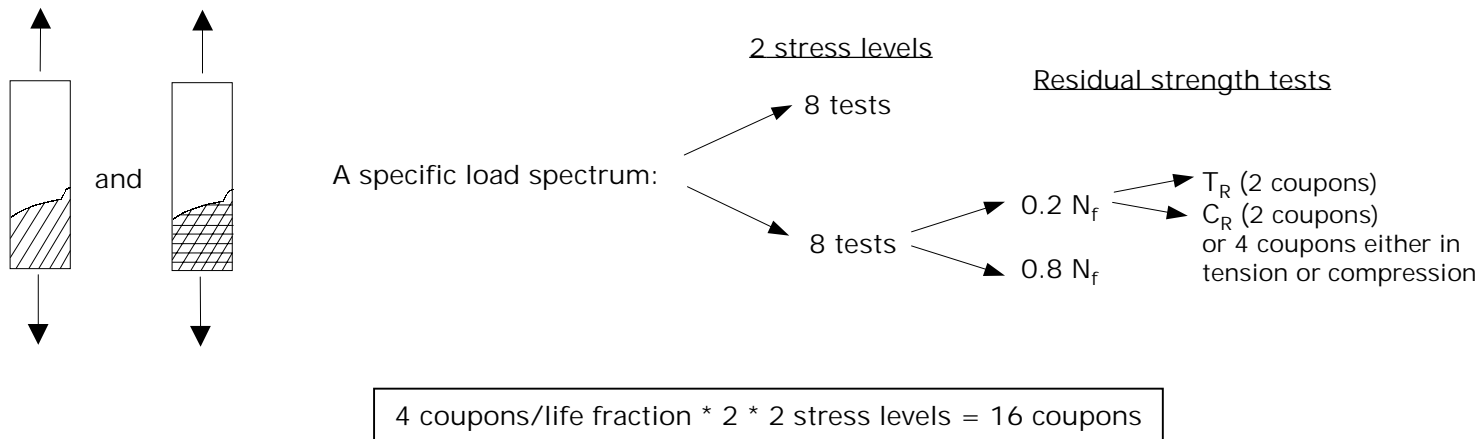
2 complex stress states * 4 specimens/life fraction * 3 = 24 specimens

Time schedule: 2 months (24 specimens)



VT3. Verification tests for residual strength

VT3.3 off-axis UD & MD after VA fatigue

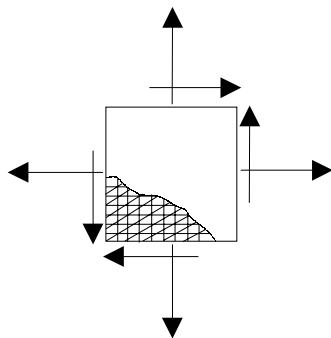


Time schedule: 0.4 months for 16 coupons. Therefore, 0.4 months * 2 (UD, MD) \approx 1.0 month (32 coupons)



VT3. Verification tests for residual strength

VT3.4 multi-axial MD after VA fatigue



At 2 different complex stress states (pressure & suction representative and where different loading axes could simulate different spectra):

Residual strength tests

0.2 N_f
0.8 N_f

4 specimens in a specific plane state of stress or 2 and 2 etc.

2 complex stress states * 4 specimens/life fraction * 2 = 16 specimens

Time schedule: 1 month (16 specimens)