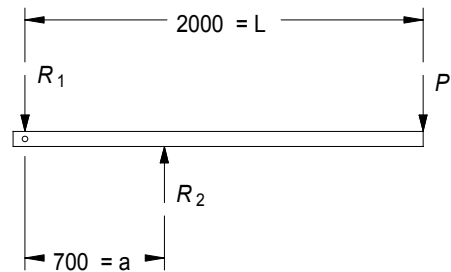## PROBLEM 6-10

Statement: An overhung diving board is shown in Figure P6-4a. A 100-kg person is standing on the free
end. Assume cross-sectional dimensions of 305 mm x 32 mm. What is the fatigue safety factor for infinite life if
the material is brittle fiberglass with Sf = 39 MPa @ N = 5E8 cycles and Sut = 130 MPa in the longitudinal
direction?

Units: $N := newton$ $kN := 10^3 \cdot N$

$MPa := 10^6 \cdot Pa$

Given: Mass of person $M := 100 \cdot kg$

Board dimensions $w := 305 \cdot mm$

$t := 32 \cdot mm$

Load dimensions $b := 700 \cdot mm$

$L := 2000 \cdot mm$

Material properties $S_{ut} := 130 \cdot MPa$

$S_{f5E8} := 39 \cdot MPa$

FIGURE 6-10
Free Body Diagram for Problem 6-10

Assumptions: 1. The given fatigue strength is fully corrected.
                   2. There are no stress-concentrations near the point of maximum moment on the diving board.

Solution: See Figure 6-10 and Mathcad file P0610.

1. This is a case of repeated bending. The FBD for this loading case is shown in Appendix D, Figure D-3a, with the
dimension a equal to L. That is, the concentrated force F is at the end of the overhung beam.

2. Determine the weight of the person on the end of the board.

Weight $W := M \cdot g$ $W = 980.7 N$ (a)

3. Figure D-3a in Appendix D shows that the maximum bending moment occurs at the right-hand support and is

$M_{max} := W \cdot (L - b)$ $M_{max} = 1.275 \times 10^6 N \cdot mm$

This is repeated bending so

$M_a := \dfrac{M_{max}}{2}$ and $M_m := M_a$

4. The stress in the board at the point of maximum bending moment is

Area moment of inertia $I := \dfrac{w \cdot t^3}{12}$ $I = 8.329 \times 10^5 mm^4$ (b)

Alternating stress $\sigma_a := \dfrac{M_a \cdot t}{2 \cdot I}$ $\sigma_a = 12.2 MPa$ (c)

Mean stress $\sigma_m := \dfrac{M_m \cdot t}{2 \cdot I}$ $\sigma_m = 12.2 MPa$ (d)

5. For repeated (fluctuating) bending, the factor of safety for Case 3 loading is

$N_f := \dfrac{S_{f5E8} \cdot S_{ut}}{\sigma_a \cdot S_{ut} + \sigma_m \cdot S_{f5E8}}$ $N_f = 2.4$ (e)