Q.2 Rolling contact bearing

Consider the work cycle acted upon bearing consist of the number of Load $W_1, W_2 \dots W_x$ and $N_1, N_2 \dots N_x$ be the speeds during those loads

During the first element the life L_1 corresponding to load W_1 is given as

$$L = \left(\frac{C}{W_1}\right)^3 \times 10^6 \text{ revolution}$$

In one revolution, the life consumed is $\frac{1}{L_1}$

$$\frac{1}{L_1} = \left(\frac{W_1}{C}\right)^3 \times \frac{1}{10^6}$$

Assume the first element consists of N_1 revolutions, so life consumed by first element is given by

$$\frac{N_1 W_1^3}{10^6 C^3}$$

Similarly, for second element

$$\frac{N_2 W_1^3}{10^6 C^3}$$

The life consumed by the complete work cycle is given by

$$\frac{N_1 W_1^3}{10^6 C^3} + \frac{N_2 W_2^3}{10^6 C^3} + \dots \frac{N_x W_x^3}{10^6 C^3} \quad \text{--- (1)}$$

If W is the equivalent load for the complete work cycle, the life consumed by the work cycle

$$\frac{N W^3}{10^6 C^3} \quad \text{--- 2}$$

where

$$N = N_1 + N_2 + \dots N_x$$

Equating equ (1) and (2)

$$N_1 W_1^3 + N_2 W_2^3 + \dots N_x W_x^3 = N W^3$$

$$W = \sqrt[3]{\frac{N_1 W_1^3 + N_2 W_2^3 + \dots N_x W_x^3}{N}}$$

$$W = \sqrt[3]{\frac{N_1 W_1^3 + N_2 W_2^3 + \dots N_x W_x^3}{N_1 + N_2 + \dots N_x}}$$

$$\boxed{W = \sqrt[3]{\frac{\Sigma N W^3}{\Sigma N}}}$$