

file, it assumed to be purely crowned. The roller equilibrium in inclined coordinate system is given by:

$$\{F\} = \begin{Bmatrix} Q_i - Q_e + F_c \cos \kappa \\ Q_f - F_c \sin \kappa \\ T_i - T_e - M_g \end{Bmatrix} = \{0\} \quad (\text{A.10})$$

By solving the roller equilibrium in Eq. (A.10), the roller displacement $\{v_k\}$ and final roller contact loads can be found by conducting iterative Newton-Raphson method. After the equilibrium equations of all rollers and for both rows are successfully solved, the inner ring equilibrium can be obtained from the following equation:

$$\{F_b\} = \{F\} + \sum_{\tau=P}^N \sum_{j=1}^Z [R\phi]^T \{Q\}_j = \{0\} \quad (\text{A.11})$$

The reactive force to the inner ring is defined as:

$$\{Q\}_j = [K]^T \begin{Bmatrix} -Q_i \\ 0 \\ -T_i \end{Bmatrix}_j \quad (\text{A.12})$$

Eq. (A.11) is solved to determine the inner ring displacements with the given external load vector $\{F\}$ and then the iterative Newton-Raphson method is used again.

B. Rating Factor, b_m

The rating factor, b_m , is determined by extracting information from existing XRBs from a bearing manufacturer. Five large-sized XRBs with bore diameters 240, 300, 340, 400, and 500 mm were used as sample XRBs. As an initial guess, b_m , is set to equal to 1 and then the dynamic load rating is calculated. Since the basic dynamic load rating is a function of several parameters such as pitch diameter, roller diameter, roller effective length, and number of rollers per row, these parameters were used to create a curved-fitted equation based on the actual rating factor of the five XRBs which includes a clamping factor to maintain the values of b_m , be limited from 1 to 1.15.

Here, b_m can be estimated as:

$$b_m = 1.075 + 0.075 \tanh[15 \hat{b}_m(d_m, D_a, l_{eff}, Z) - c] \quad (\text{B.1})$$

where, $\hat{b}_m(d_m, D_a, l_{eff}, Z)$ is a function of the bearing pitch diameter, roller diameter, effective length, and number of rollers per row which can be determined as:

$$\hat{b}_m(d_m, D_a, l_{eff}, Z) = e^X \quad (\text{B.2})$$

The exponent X is defined by:

$$X = c_0 + c_1 \ln d_m + c_2 \ln D_a + c_3 \ln l_{eff} + c_4 \ln Z \quad (\text{B.3})$$

where $c_0 = -6.1567\text{e-}1$, $c_1 = 3.8079\text{e-}1$, $c_2 = -4.6971\text{e-}1$, $c_3 =$

Table B1 Rating factor estimation

XRB designation	Axial dynamic load rating [N]		Error	b_m
	Catalog	ISO 281:2007	%	Estimated
SX011814	16,000	13,964	12.73	1.1457953
SX011848	149,000	134,534	9.71	1.1075267
SX011860	245,000	227778	7.03	1.0756087
SX011868	265,000	239225	9.73	1.1077438
SX011880	385,000	356,554	7.39	1.0797796
SX0118/500	550,000	508,872	7.48	1.0808219

$3.5962\text{e-}2$, and $c_4 = -9.6043\text{e-}2$. Following the curve-fitting procedure, this rating factor is applied to the investigated XRB to estimate its basic dynamic load rating, ensuring alignment with the catalog values provided by the bearing manufacturer.



Gilbert Rivera

Postmaster Researcher in Kumoh National Institute of Technology (KIT). His research interests are Bearing modeling and Rotor Dynamics.

E-mail: gibrivera@kumoh.ac.kr



Dong-Hyeok Kim

M.E. Candidate in Mechanical Engineering at Kumoh National Institute of Technology (KIT). His research interest is Bearing Modeling and Analysis.

E-mail: 20236012@kumoh.ac.kr



Dong Uk Kim

Researcher in Electronic Component Development Group, Korea Research Institute for Defense Technology Planning and Advancement (KRIT). His research interests include Computational Fluid Dynamics and Development of Defense Industry.

E-mail: donguk1@krit.re.kr



Seong-Wook Hong

Professor in the Department of Mechanical System Engineering of Kumoh National Institute of Technology. His current research interests include Spindle and Bearings Modeling and Analysis, Command Shaping for Positioning Systems, Vibration Control, and Structural Vibration Analysis for Mechanical Systems.

E-mail: swhong@kumoh.ac.kr