Experimental and Theoretical Approach to Generalized Empirical Data-based Model of Noise in Ceiling Fan

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(Received 16 June 2014; accepted 9 December 2014)

This study investigates the design of experimental work to be executed for establishing an approximate generalized empirical model for the noise of a ceiling fan on the basis of experimental data and the methodology of engineering experimentation. It includes the design of an experimental setup, the formulation of a generalized empirical data-based model, that model's sensitivity analysis, and reliability and optimization for the analysis of ceiling fan noise. The formulation and analysis of the noise model are completely covered in this paper to analyse the impact of various input parameters on the output parameter, *i.e.* the noise of a ceiling fan.

NOMENCLATURE

Nomenclature is given in Table 1.

Table 1. List of input and output variable with their nomenclature.

Independent Variable			Notation
Blade parameters (Π_1)		Number of blades	N_{bl}
		Blade Thickness	T_{bl}
		Blade Width	W_{bl}
		Blade Sweep	SW_{bl}
		Blade Length	L_{bl}
		Blade root twist angle	θ_{bltw}
		Blade tip lift angle	θ_{bllf}
		Modulus of Elasticity of Blade material	E_{bl}
Bearing parameters (Π_2)	Bearing No. 1	Bearing Bore Diameter	BD_{be1}
		Bearing Outer Diameter	OD_{be1}
		Bearing Width	W_{be1}
		Bearing Radius	R_{be1}
		Basic Dynamic Load Rating	C_{be1}
		Basic Static Load Rating	C_{Obe1}
		Number of Balls	NOB_{be1}
		Ball Size	BS_{be1}
		Maximum runout speed-Grease	GR_{be1}
		Maximum runout speed-Oil	OR_{be1}
		Bearing weight	Wt_{be1}
		Modulus of Elasticity of Bearing material	E_{be1}
		Number of bearings	N_{be1}
		Bearing Number	BN_{be1}
	Bearing No. 2	Bearing Bore Diameter	BD_{be2}
		Bearing Outer Diameter	OD_{be2}
		Bearing Width	W_{be2}
		Bearing Radius	R_{be2}
		Basic Dynamic Load Rating	C_{be2}
		Basic Static Load Rating	C_{Obe2}
		Number of Balls	NOB_{be2}
		Ball Size	BS_{be2}
		Maximum run out speed-Grease	GR_{be2}
		Maximum run out speed-Oil	OR_{be2}
		Bearing weight	Wt_{be2}
		Modulus of Elasticity of Bearing material	E_{be2}
		Number of bearings	N_{be2}
		Bearing Number	BN_{be2}

Table 1. List of input and output variable with their nomenclature (continued).

Clamp Parameters (Π_3)	Clamp Length	L_c
	Clamp Thickness	T_c
	Number of Holes on Clamp	N_h
	Modulus of Elasticity of Clamp material	E_c
Fasteners and Shaft (Π_4)	Number of nut and bolts	N_{nb}
	Number of Screws	N_{sc}
	Number of washers	N_w
	Room length	L_r
Field Parameters (Π_5)	Room height	H_r
	Room width	W_r
	Room Area	A_r
	Volume of room	V_r
	Acceleration due to gravity	g
	Area of structural member	A_s
	Volume of structural member	V_s
	Distance between ceiling and plane of rotation	L
	Atmospheric humidity	ϕ
	Atmospheric Temperature	T
	Air Delivery	V_a
Motor Parameters (Π_6)	Power	P
	Current	I
	Voltage	V
	Fan speed in RPM	N
	Capacitor	C
	Dependent Variable	Notation
Output Parameter (ΠD_1)	Noise	NOI

1. INTRODUCTION

Fans are used in homes, industries, hospitals, offices, schools, and colleges. Ceiling fans can provide years of comfort and beauty. The first ceiling fans appeared in the early 1860s and 1870s, in the United States, and were designed by Duchess Melissa Rinaldi during her stay in the Rocky Mountains. At that time, they were powered by a stream of running water, in conjunction with a turbine to drive the system. The electrically powered ceiling fan was invented in 1882 by Philip Diehl. Each fan had its own self-contained motor unit, with no need for belt drive.[1] By the 1920s, ceiling fans had become