DEDICATION

...TO MY PARENTS

.AND TO, MY BROTHERS

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ABSTRACTS

The model of a horizontal – axis wind turbine was designed to generate 164 watts. Execution of design include the design of the rotor (3 m diameter) which is made of three wooden blades of a cambered airfoil section (NACA 4412 section), the blades were manufactured locally. The rotor is coupled to a small D.C. generator via a belt transmission system. The designs of the transmission subsystems (belts, shafts, and bearings) were achieved. The wind .generator model is installed on a tower 3 meters above ground

A field test was carried out on a wind generator model at the Soba field owned by the Energy Research Institute. The output voltage and current were measured to determine the amount of .electricity generated by the model

After the test, it was found that the efficiency of the model is low. This was mainly due to the decrease of the wind speed at the 3 meters above ground (the height of the tower). In addition to that, the locally available technologies restrict the possibilities of manufacturing blades with the airfoil shapes that can extracts power .with high efficiency

CONTENTS

LIST OF SYMBOLS

a	axial induction (interference) factor	dimensionless
a^{-}	tangential induction (interference) factor	dimensionless
A	area	m^2
$A_{R\ proj.}$	the projected area of the rotor blades	m^2
$A_{T\ proj.}$	the projected area of the tower	m^2
B	number of blades	dimensionless
B_x	bending factor with respect to x – axis	cm^{-1}
B_y	bending factor with respect to y – axis	cm^{-1}
c_t	coefficient of wind pressure	dimensionless
C	chord of blade	m
C_c	the critical slenderness ratio	dimensionless
C_{column}	slenderness ratio of column	"
C_d	sectional drag coefficient	"
C_D	blade drag coefficient	"
C_l	sectional lift coefficient	"
C_{ld}	design lift coefficient	"
C_L	blade lift coefficient	"
C_p	power coefficient	"
C_Q	torque coefficient	"
C_T	thrust coefficient	"
D	diameter	m
D	drag force	N
e	distance rotor plane – vertical axis	m
e_r	eccentricity of the rotor	m
E	modulus of elasticity	N/mm^2
f	frequency	1/s

f_a	actual column stress	N/mm^2
f_y	yield stress	N/mm^2
f.s.	factor of safety	dimensionless
f_{bx}	actual bending stress about x – axis	N/mm^2
f_{by}	actual bending stress about y – axis	N/mm^2
F	force	N
F_a	allowable column stress	N/mm^2
F_{bx}	allowable bending stress about x – axis	N/mm^2
F_{by}	allowable bending stress about y – axis	N/mm^2
F_w	wind pressure	N/m^2
g	acceleration of gravity	m/s^2
h	altitude	m
H	height of the tower	m
K	effective length factor	dimensionless
k_x	drag force	N
$k^{\sim}_x$	fluctuating force	N
k_y	yaw force	N
k_z	vertical force	N
l	length	m
L	length of column	m
L	lift force	N
m	mass of the rotor	kg
$m^{'}$	mass flow rate	kg
M	moment	Nm
M_x	moment about x – axis	Nm
M_y	moment about y – axis	Nm
M_z	moment about z – axis	Nm
P	pressure	N/m^2
P^+	static pressure before the rotor	N/m^2

$\bar{P}$	static pressure behind the rotor	N/m^2
P	power	W
$P_{equi.}$	Equivalent axial compression load	N
Q	torque	Nm
r	local radius	m
R	radius	m
S	section modulus	cm^3
S_x	section modulus with respect to x – axis	cm^3
S_y	section modulus with respect to y – axis	cm^3
T	thrust force	N
V	wind velocity	m/s
V_{ax}	axial velocity through rotor	m/s
V_1, V_∞	undisturbed wind velocity	m/s
$\bar{V}$	average wind velocity	m/s
V_2	wind velocity behind the rotor	m/s
V_{storm}	peak velocity in storm	m/s
W	relative wind velocity	m/s
W_t	weight	kg/m
z	coordinate height	m
z_o	roughness height	m
z_r	reference height	m

α	angle of attack	dimensionless
α_d	design angle of attack	"
β	blade setting angle	"
δ	angle between the wind velocity and rotor axis	"
η	efficiency	"
λ	tip speed ratio	"
λ_d	design tip speed ratio	"
λ_r	local tip speed ratio	"
π	3.14159265359	"
ρ	density	kg/m^2
σ	solidity ratio of the rotor	dimensionless
Φ	angle between relative wind direction and rotor plane	"
ω	induced tangential angular wind velocity	1/s
Ω	angular velocity of the rotor	1/s
φ_1	a factor of the dynamic influence of the wind	dimensionless

STUDY AND DESIGN OF A HORIZONTAL AXIS – WIND TURBINE FOR ELECTRICITY GENERATION

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