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Energy Production in Smart Cities by Utilization of Kinetic Energy of Vehicles Over Speed Breaker

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ABSTRACT

Smart city deals with the problems of rapid urbanization and population growth by optimal utilization of all available resources. There are other driving factors such as clean energy programmes, a low carbon economy and distributed energy resources that are included in a smart city concept. Therefore, in this article, the authors proposed a clean energy generating model by utilizing the kinetic energy of vehicles over a speed breaker. The article focused on the design, modelling, and simulation of an electromechanical system for generating electrical power from the kinetic energy of vehicles passing over speed breakers. To facilitate simulation, a model of the electromechanical system is developed in MATLAB/Simulink. Further, MULTISIM 14 software is utilized for power electronic device modelling and simulation. Simulation results for power generation are obtained considering four units of rotational induction generators and two units of translational induction generators.

KEYWORDS

Boost Converter, Inverter, Rotational Induction, Translational Induction

VARIABLES

$\omega_{ratchet}$ Angular speed of the ratchet gear
ω_{pinion} Angular speed of the pinion gear
$N_{ratchet}$ No. of tooth on ratchet gear
N_{pinion} No. of tooth on pinion gear
δ Deflection of a spring
d Diameter of a wire
n Number of springs
G Modulus of rigidity
R Mean diameter of a spring coil
W Effective designed load
n_a Number of active spring turns
n_t Total number of spring turns

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p Pitch of a spring

l Actual length of a spring
n_t Total number of spring turns
P Developed Power
K spring constant
g Acceleration due to gravity
x Spring deflection length
Φ Flux per pole
Z Total number of armature conductors
E_g Induced EMF in any parallel path in armature
μ0 Permeability of a free space
z Relative axial distance from the center of the coil to the magnet
r Average coil radial distance from the centre of the magnet
B_ρ The radial component of the magnetic flux density
l_w Total length of the coil wire inside the magnetic field
μ0 Permeability ($4\pi\times10-7$ N/A^2) of a vacuum,
μ Magnetic dipole moment
σ Electric conductivity
v Velocity of the magnet
N Number of turns wrung on the cylindrical pipe external part
V_i Input voltage
V_0 Average output voltage
t_{on} "ON" state duration
t_{off} "OFF" state duration
Ts Switching period
D Duty cycle
I_i Average input current
I_0 Average output current
f_s Switching frequency
R Equivalent load resistance
A Voltage gain
K_s Packing coefficient
K_r Filling coefficient
L_p Net thickness of the iron package
Ku Utilization factor
$\varnothing$ Flux per column
L_{gross} Gross thickness
μ_i Induced EMF per turns
I_1 Primary winding current
I_2 Secondary winding current
A_{copper} Wire diameter
B_P Number of batteries wired in parallel
V_{sin} Sinusoidal voltage peak magnitude
V_{tri} Triangular carrier peak magnitude