passage through the heterogeneous material and depends on the ratio of the acoustic wave resistances of the cement matrix and coarse aggregate.

The attenuation coefficients of heavy and lightweight concrete were calculated with a special program in LabView. The attenuation coefficient in lightweight concrete is 919.5 s^{-1}, and in heavy concrete it is 696.3 s^{-1}. Since the acoustic wave resistances in gravel and keramzit are significantly different, the character of signal attenuation in these materials is different [4].

The conducted investigations show that the parameters of the electric response depend on the composition of the coarse aggregate in concrete and can be used for its testing.

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MODELLING OF PV – MODULE BASED ON DATA SHEET PARAMETERS

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Abstract – The PV module is the interface, which converts light into electricity. Modelling of this device requires weather data (irradiance and temperature) as input variables. The output can be current, voltage, power.

Any change in the inputs immediately leads to changes in the outputs. That is why, it is important to use an accurate model for the PV module. This paper presents a modelling of the effect of irradiance and temperature on the I-V and P-V characteristics of the PV module. The chosen model is a single diode model with both series and parallel resistors for greater accuracy. The modelling is simulated using Matlab/Simulink and Matlab/Guide software.

Key words – PV electrical characteristics, single-diode model, Matlab/Simulink, Matlab/Guide.

1.

2.INTRODUCTION

The main electrical characteristics of PV cell and module usually are given on the data sheet. However, most of the manufacturers' data sheets do not give enough information about the parameters, which depend on weather conditions (temperature and irradiance). The objective of this paper is to present the modelling of I-V and P-V characteristics of the PV module.

3.PV MODULE MODELLING

2.1.Electrical characteristics of the PV module

To simulate the PV module the main electrical characteristics from the data sheet have been used. These parameters are under test conditions of irradiance of 1 kW/m^2, and cell temperature of 25 C.

Table 1. Electrical characteristics of PV module.

Peak Power	Total number of cells in series (Ns)
Voltage at Maximum power (Vmp)	Total number of cells in parallel (Np)
Current at Maximum power (Imp)	Coefficient temperature of short circuit current (A/K)
Open circuit voltage (Voc)	

2.2.Determination of the parameters

PV cells are usually represented by a simplified equivalent circuit model such as given in Fig.1:

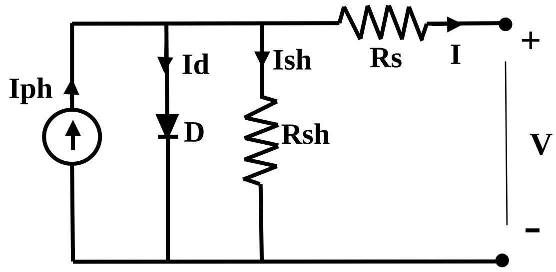

Fig .1. The equivalent circuit of a solar cell

By applying Kirchhoff law, the current will be obtained by the equation:

$$I = I_{ph} - I_d - I_{sh}, \qquad (1)$$

In turn, Iph, Id and Ish are determined by the following formulas:

$$I_{ph} = \frac{G}{Gref} - \left(I_{ph,ref} + \mu_{sc} \cdot \Delta T\right), (3)$$

$$I_d = I_0 \cdot \left[\exp\left(\frac{(V + I \cdot R_s) \cdot q}{N_s \cdot A \cdot k \cdot T} \right) - 1 \right], (4)$$

$$I_{sh} = \frac{V + I \cdot R_s}{R_p}, (5)$$

where the symbols are defined as follows:

I_{ph} is photocurrent, A

I_0 is diode saturation current, A

R_{sh} is shun resistance, Ohm

R_s is series resistance, Ohm

k is Boltzmann's constant ($1.38 \cdot 10^{-23}$)

q is electron charge ($1.602 \cdot 10^{-19} C$)

A is ideality factor

U is thermal voltage, V

2.3.Modelling of the PV module in Matlab/Simulink

The simulations of the above parameters are shown in Figures 2–5:

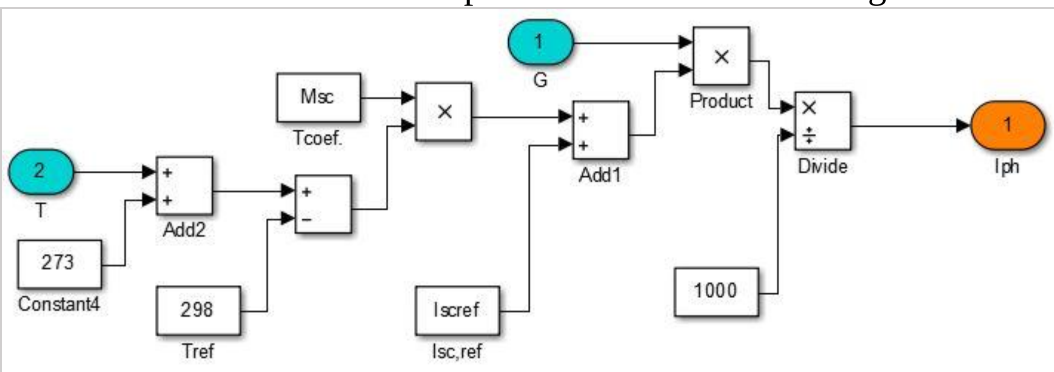

Fig. 2. Subsystem Iph implementation

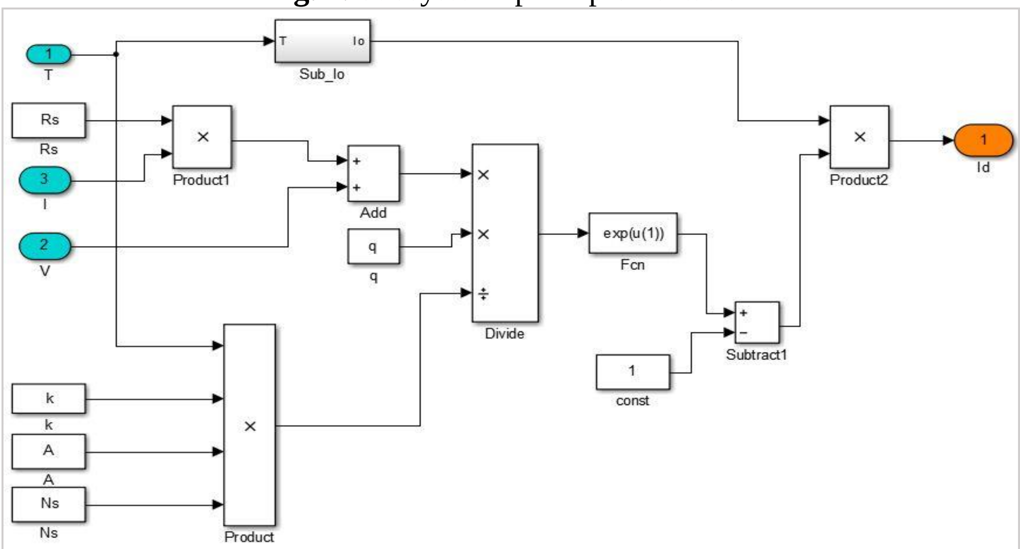

Fig. 3. Subsystem Id implementation

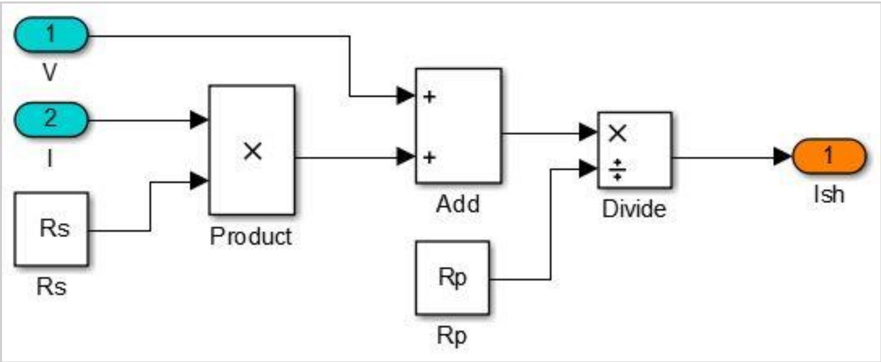

Fig. 4. Subsystem Ish implementation

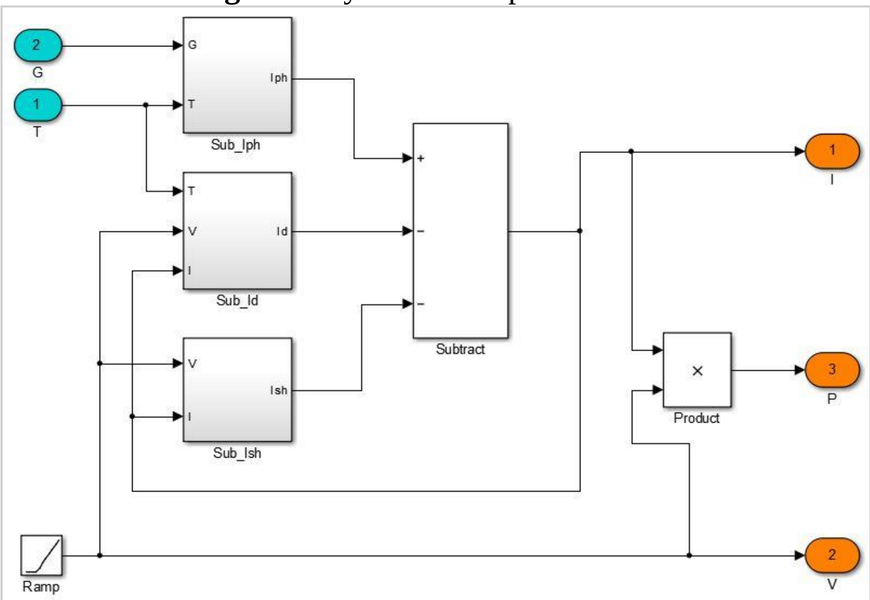

Fig. 5. Model of the PV module

3. CONCLUSIONS

The presented work is a modelling and simulation of the PV cell and module in Matlab/Simulink environment. The PV module parameters have been selected according to their variation with the irradiance level and temperature. It means that for any type of the PV module, this model can be used to obtain the I-V and P-V characteristics.

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