ACHIEVEMENT OF EXECUTION DOCUMENTATION
FOR EXPERIMENTAL MODEL

Activity II.1 Drawing up of a method for improving the structure of Roebel-type bars

On the basis of the established calculation relations, it was developed the program ROBARUPT in FORTRAN Power Station, by means of which the electro-thermal effect losses in the bar can be determined for any current varying sinusoidally in time, for any transposition of the elementary conductors, either solid or hollow one, like in the case of direct cooling by fluids. The program structure is given in Figure 8.

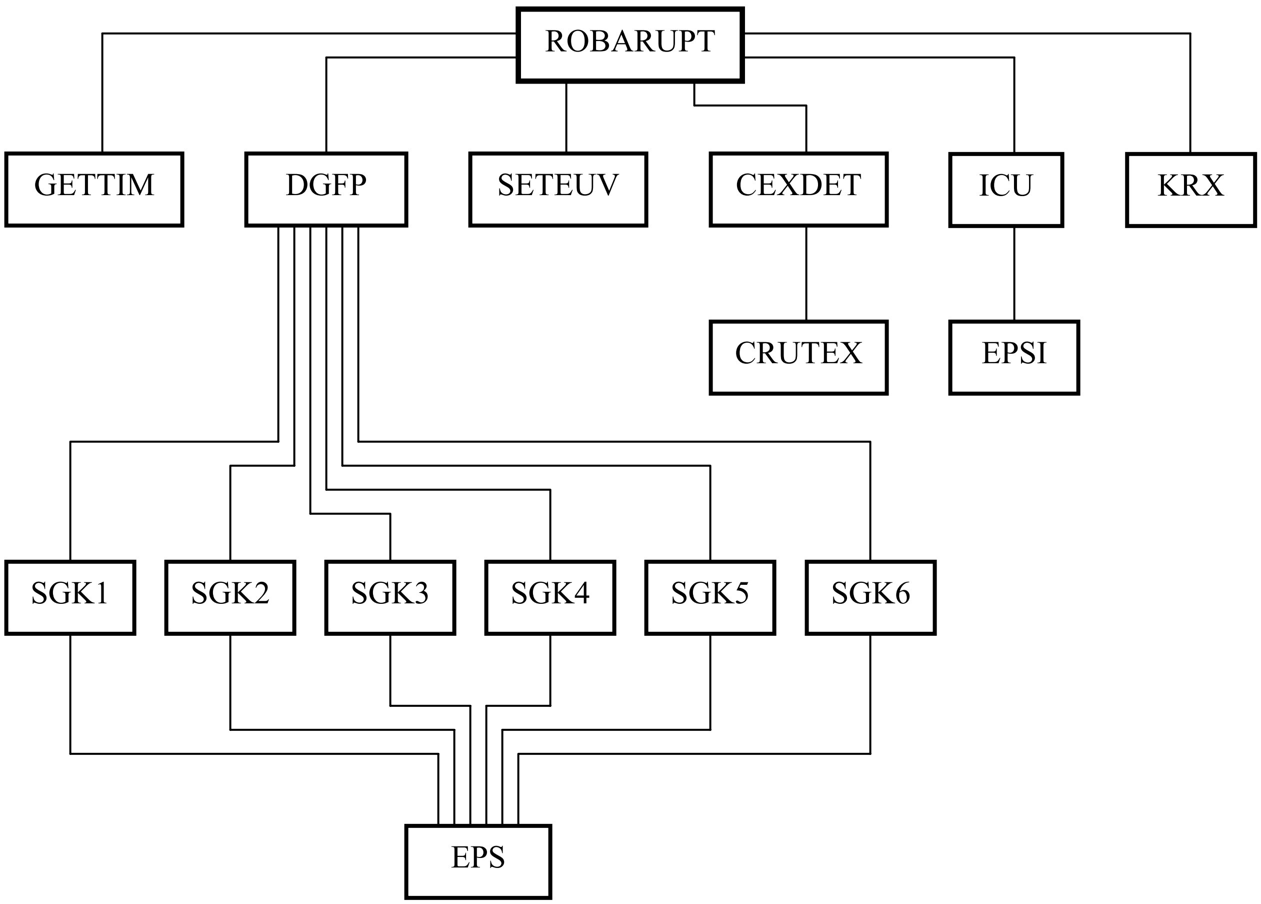

Fig.8

where:

ROBARUPT.FOR is the main program. Within this program, it is commanded the reading of the input data, their saving into a file for controlling the correctness of data reading, it is chosen the calculation method, there are performed the calculations for the variables having values non-modified by the auxiliary programs on which, by COMMONs, there are transferred the sub-programs in which they are necessary, there are called the sub-programs for performing calculations and there are printed the current and final results.

SETEUV.FOR calculates recursive functions, necessary for performing calculations corresponding to the parts of the bar which are located in the two ends and in the machine slot.

CEXDET.FOR receives the coefficients calculated in the main program corresponding to the 2m equations which are defining for the currents flowing through the elementary conductors of the bar and, by using the sub-routine CRUTEX.FOR, performs the calculations necessary for determining the values of the currents from the elementary conductors. By means of a COMMON instruction, the results are sent to the main program.

ICU.FOR is a sub-program by means of which there are calculated the currents $\underline{I}_{c\lambda}$ and $\underline{I}_{u\lambda}$ from the relation (8), necessary for calculating the current $\underline{I}_{\upsilon}$ from the band corresponding to the conductor through which the current $\underline{I}_{\xi}$ flows, using the data provided by the sub-program EPSI.FOR.

DGFP.FOR by means of the sub-programs SGK1,...,SGK6, calculates the variables necessary for calculating the coefficients from the relation (12) from the equations which are defining for the currents in elementary conductors.

KRX.FOR is the program calculating the electro-thermal effect losses from the elementary conductors and finally in the bar. At the same time, the coefficients for modifying the AC electric resistance in the elementary conductors for the three segments (from the two bar ends and from the slot), for the entire elementary conductor and finally for the bar are calculated.

The program, under execution form, can be launched by a command .bat and performs the calculations under two forms.

- One calculates only one bar, for which all the necessary elements have been specified;
- One performs an improving calculation, i.e. for identifying the bar which, for a given current I, by means of many variants and modifying the bar height, the number of elementary conductors and the transposition angle, has the minimal losses. The results are written in a final table, one line for each height of the considered bar; from this table, the optimal bar with minimal losses can be identified.

Activity II.2 Drawing up of the preliminary project theme for the experimental model with Roebel bar

The experimental model contains:

- One or many bars made of elementary bunched cable, with different structures, for measuring the additional losses and coefficient of AC resistance increase; elementary conductors made of copper, with rectangular shape, are used
- One bar made of elementary conductors short-circuited at the ends, provided with one current transducer on each conductor, for measuring the elementary current; the determination of current distribution in the bar section for emphasizing the upsetting effect is followed.
- One elementary magnetic circuit containing two teeth and the corresponding part from the hydrogenerator stator yoke; the magnetic circuit is made of siliceous sheets, used for manufacturing the electric machine stators (thickness 0.5 mm); the space between the two teeth represents the hydrogenerator slot where the bar is located; the length of this magnetic circuit is equal to the length of the hydrogenerator stator package which was chosen for modeling, and also equal to the length of the section on which the conductor stranding is done.

Technical specification of the experimental model:

S_N = 22 MVA
U_N = 10.5 kV, star connection
I_N = 1210 A
$\cos\varphi_N = 0.9$
Stator length: 0.9 m
Developed bar length: 1.845 m
Number of elementary conductors: 28
Cross-section of elementary conductor: 6.3 x 2.5 mm^2
Stranding angle on the slot zone: 2π
Total bar section (with slot insulation): 47.8 x 19.1 mm^2

Activity II.3 Drawing up of the execution documentation for the experimental model with Roebel bars

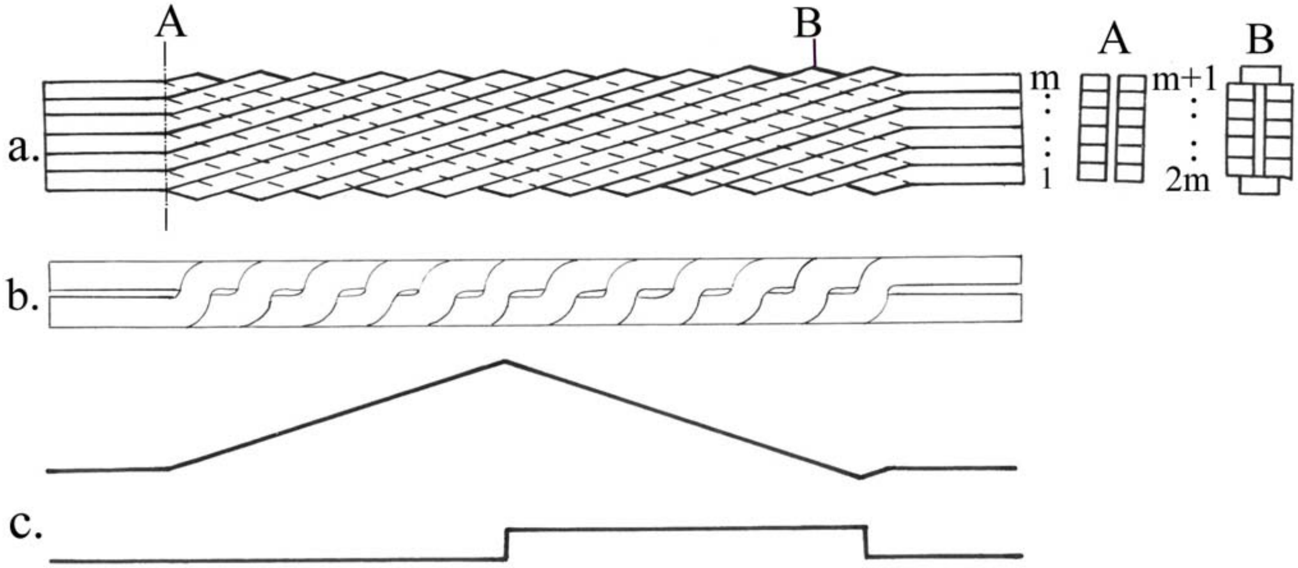

Fig.1. Roebel bar