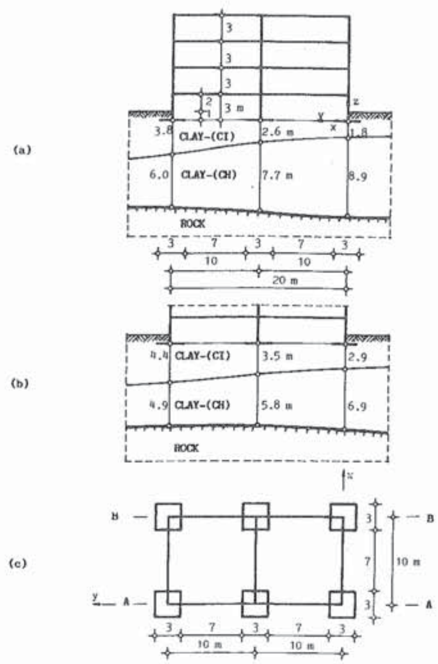

Fig. 2 Stratigraphical data and basic physical characteristics of non-homogenous soil halfspace (See Table II.).

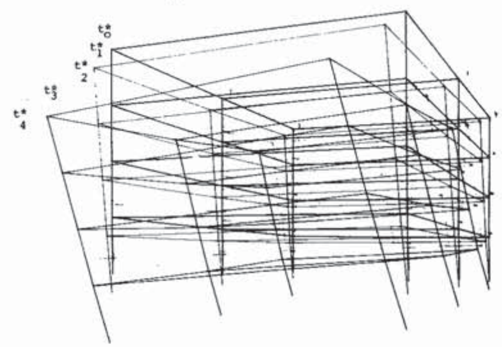

Fig. 3 Time (t^*_r) and load (P_r) dependant (See Table I.) displacements and settlements (increased 15 times) of skeleton structure.

User experience of MICROPAS, SERI-RES and DEROB - similarities, problems and comparisons

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KEYWORDS

MICROPAS, SERI-RES, DEROB, Passive solar, Residential Buildings, Computer Simulation.

ABSTRACT

As of late 1983 the Energy Research Group has been a participant in Task VIII of the International Energy Agency's (IEA) Solar Heating and Cooling Program. The objective of Task VIII is to accelerate the development and use of Passive and Hybrid Solar Low Energy Buildings. With this objective in mind, the authors have been both evaluating, and performing parametric studies with, thermal simulation computer models. The major part of this work has involved the two computer programs MICROPAS and SERI-RES, although some work has been carried out on DEROB V1.0 - IUA. While working with these programs, we have paid particular attention to the completeness of the documentation, and the ease of understanding of the input requirements. Similarities and differences between these programs are documented, and the thermal performance of buildings as predicted by these programs are compared. From the point of view of a New Zealand user, MICROPAS is inadequate, predominantly due to the fact that it can only use imperial units. The input requirements of DEROB are relatively complicated, due to the graphics facilities available. SERI-RES appeared to be the most user-friendly program of the three.

Expérience de l'usager de MICROPAS, SERI-RES et DEROB - similarités, problèmes et comparaisons

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MOTS-CLEFS

MICROPAS, SERI-RES, DEROB, Solaire passif, Bâtiments résidentiels, Simulation par ordinateur

SOMMAIRE

Depuis la fin 1983 le groupe de recherche sur l'énergie a participé à Task VIII, programme de chauffage et refroidissement solaire de l'agence internationale sur l'énergie (IEA). L'objet de task VIII est d'accélérer le développement et l'utilisation d'énergie solaire passive et hybride et celle de bâtiments faibles utilisateurs d'énergie. Avec cet objectif en tête, les auteurs ont évalué aussi bien que pratiqué des études paramétriques à l'aide de modèles de simulations thermiques et ceci par l'entremise d'un ordinateur. La plus grande partie de ce travail s'est effectuée à l'aide des deux programmes d'ordinateur MICROPAS et SERI-RES, bien qu'une petite partie ait aussi été exécutée sur DEROB V1.0-IUA. Pendant que nous travaillions avec ces programmes nous avons fait particulièrement attention à ce que la documentation soit complète, et qu'il soit facile de comprendre les exigences de l'information fournie. Les ressemblances et les différences entre ces programmes sont documentées se les prestations thermales des bâtiments, prévues par ces programmes sont comparées. Au point de vue de l'utilisateur néo-zélandais, MICROPAS est inadéquat, ceci dû en majeure partie au fait qu'il n'utilise que des mesures impériales (système anglais). Les exigences de l'information fournie par DEROB sont relativement compliquées et ceci dû à la graphique à disposition. SERI-RES apparaît comme le programme le plus facile d'accès des trois cités ci-dessus.

INTRODUCTION

Since late 1983, the Energy Research Group (ERG) has been participating in an International Energy Agency (IEA) co-operative research project. The project is entitled 'Passive and Hybrid Solar Low Energy Buildings' [1] and the ERG research is supported by the New Zealand Energy Research and Development Committee. The project is organised within the Solar Heating and Cooling Programme of the IEA.

Part of the work of the project is to test the accuracy of building thermal design tools. The tools that are available internationally range from rules-of-thumb, through manual calculation methods, to computer programs. Individual countries make their own selection of design tools for testing.

The specific activities in which New Zealand has direct involvement are:

Subtask 0: Technology Baseline Definition
- in which standard base houses for comparison are established, and

Subtask C: Design Methods
- in which an international design handbook, design tools and individual country construction handbooks will be produced.

To a lesser extent, New Zealand has also involved itself in another activity:

Subtask B: Modelling and Simulation
- in which parametric studies are performed on selected simulation models for evaluation purposes.

SCOPE OF THE RESEARCH

Subtasks B and C are primarily interested in testing the accuracy with which currently available design tools predict the heating, cooling and ventilation loads that are required to keep the thermal comfort of a house within defined limits.

In general, New Zealand's climate is such that natural ventilation is sufficient to keep internal house temperatures from becoming uncomfortable. As a result of this, very few houses are built with either a cooling or a mechanical ventilation system. Therefore, ERG has concentrated its studies on the heating load. From this load, the annual energy cost requirements of a building can easily be determined. ERG was also interested in evaluating the ease of use of the design tools.

A base design tool was required in order to facilitate comparison of the findings of the different countries. The computer program SERI-RES [2] (version 1.0 of the program now sold as SUNCODE in the USA) was selected, to fulfil this requirement. One of the reasons for the selection of SERI-RES is that it is one of the few programs that have had validation tests performed against both test cells and houses [3]. The cell tests were for direct gain, trombe wall and sunspace designs, while the house tests have been for direct gain and sunspace designs.

THE PROGRAMS

In order to perform these evaluations, we obtained SERI-RES from EMPA in Switzerland, and purchased MICROPAS from ENERCOMP in the USA [4]. We have since acquired the program DEROB-IUA V1.0 from NBRI in South Africa [5], and more recently a pre-release version of SUNCODE-PC from ECOTOPE in the USA.

SERI-RES is a general purpose thermal analysis program for residential and small commercial buildings. It utilizes a minicomputer to run an hour-by-hour simulation analysis upon a thermal model of the building for the length of the run, usually a year. The program allows a more accurate generation of both the peak power and annual energy requirements than can be provided by traditional rules of thumb. The thermal analysis requires a climatic data file which contains hourly measurements of the weather conditions over a period of at least one year. We are running SERI-RES on a VAX780 computer.

MICROPAS is a residential building energy analysis program designed for easy use on microcomputers. Due to limitations in the size of microcomputers at the time the program was developed, the program carries out a simulation analysis upon a thermal model using a compressed weather data file. This file provides data for an average week for each of six program-defined simulation seasons. The results of the six season simulations are then extrapolated to provide the peak power and annual energy requirements for the year. We run MICROPAS on an IBM-XT with 512 KBytes of RAM, and an 8087 maths co-processor (the 8087 is not required to run MICROPAS).

DEROB is a thermal simulation program useful for a wide range of buildings, from small residential through to large commercial. It utilizes a mainframe computer to perform a detailed hour-by-hour analysis upon a building model. The analysis includes the determination of which surfaces within the building are receiving direct sunlight, and hence is able to determine how much thermal energy is absorbed by each building surface more accurately than most simulation programs. The draw back of this is that DEROB takes longer to perform a simulation than the previous two programs. We run DEROB on an IBM 4341 computer.

SUNCODE-PC is a microcomputer version of SUNCODE. Some of the algorithms of SUNCODE have been altered from the original SERI-RES, in an effort to improve the performance of the program. Due to the continuing advances in microcomputer technology, SUNCODE-PC is able to utilize the same hourly climatic data file as used by SERI-RES. However, rationalization of some of the FORTRAN coding was required to enable the program to be compiled by the smaller computer. We run SUNCODE-PC on an IBM-XT with 512 KBytes of RAM, and an 8087 maths co-processor (the 8087 is required to run SUNCODE-PC).

TEST METHODOLOGY

To assist in the evaluation of design tools being undertaken within Task 8, six simple buildings were devised (by the Task 8 Expert Group) for the design tools to analyse thermally. All the buildings had a floor area of 48 square meters and a ceiling height of 5 meters, representing a two storey single family detached house. The first of these is a windowless light timber framed building, and serves as a baseline for the remaining five cases. The five cases incorporate variations in window area, thermal mass levels and ground coupling.

For building 2, 9 square meters of glazing was added to the equatorial (north) wall. All windows are assumed to be double glazed with a U-value of 2.669 W/m.m.C. For building 3, a total of 18 square meters of glazing was added to the equatorial wall. Building 4 has a total of 9 square meters of glazing on both the equatorial and east walls.

Building 5 is glazed as the third building, but instead of the timber framed walls and floor, it has a 10cm thick slab of concrete for all these surfaces (different from the Expert Group's version). Building 6 is also glazed as the third building, but has the concrete slab for the floor only (the walls are light timber framed). The floor is also assumed to be sitting on the ground for building 6. For both buildings 5 and 6, the distribution of solar radiation is 15% to the air, 60% to the free mass and 25% to the floor. In the other buildings, the distribution of the solar radiation transmitted into the zone was modelled at 50% going to the air, and 50% going to the free mass.

ANALYSIS OF RESULTS

Each of these six buildings were modelled with SERI-RES, MICROPAS and SUNCODE-PC. We were interested in the time it took for each package to perform the simulation, and the comparative results that each produced. The results that were tabulated ranged from the heat losses through the building fabric and due to infiltration, to the gains from both solar radiation and the heat supplied by the plant to keep the building at a minimum temperature of 20 C. Table I records both the results obtained from the runs, and the time taken for the simulation.

We would have expected the SERI-RES and SUNCODE-PC results in Table I to be the same within a tolerance of about 5%. However, the gains predicted by SUNCODE-PC exceed those of SERI-RES by 24% in all cases. This highlights a discrepancy between the two programs that may well be due to the algorithm changes that have occurred. For the predicted losses and heating load, the two programs correlate reasonably well, but it is not possible at this stage to determine whether this would remain the case if the gains were similar.

For the light timber framed buildings, the value for heat losses predicted by MICROPAS are about 15% greater than those by SERI-RES. This increase is accounted for equally by losses through the windows and opaque surfaces, and losses due to infiltration. Similarly, a 10% greater value for solar gains is predicted by MICROPAS. The heating load for the first two buildings exceeds SERI-RES by 15%, but for the third and fourth building, it is 15% less than that for SERI-RES. The main difference between these buildings is that the latter two have a greater window area than the first two. This suggests that MICROPAS 'assumes' that a greater percentage of the solar gains are useful than does SERI-RES. The column showing the percentage of gains utilized demonstrates the relative size of the differences between programs.

For the heavy mass building 5, MICROPAS predicts double the heat loss predicted by SERI-RES. The increase in heat loss is attributable to the opaque surfaces, in this case the mass walls and floor, which have a much lower thermal resistance than the first four buildings. For some reason, MICROPAS has great difficulty determining the heating load required for this building, given the high losses and the low solar gains achieved. The modelling of this particular building approaches the limits of what MICROPAS is able to model. The losses for building 6 are 75% greater than that modelled by SERI-RES. The increased loss can be tied to the amount of heat escaping through the floor and into the ground. As a result, MICROPAS predicts a very different heating load to that determined by SERI-RES.

EASE OF USE OF THE DESIGN TOOLS

The last column of Table I records the length of time each run took. For MICROPAS and SUNCODE-PC, this is the actual time that was waited for the completion of the run, whereas for SERI-RES, it records the amount of time that the computer spent on the simulation. As SERI-RES is run on a large computer, it has to be shared with other users, and hence the actual time that you may have to wait for your results depends on how many users are competing for time on the machine. From the point of view of most designers, a mini-computer is too expensive to buy, and hence SERI-RES would not be a suitable design tool.

A simulation with SUNCODE-PC takes about four times as long as does MICROPAS. Despite this, if the designer was more interested in the actual heating load of a design (for determination of heating costs), we would advise him/her to use SUNCODE-PC. Our reasoning is that MICROPAS extrapolates the annual heating load from 6 weeks of weather data, which is not likely to be as accurate as SUNCODE-PC's use of a full year's data. However, if all that was required was comparisons between different design options, then MICROPAS would be preferable to SUNCODE-PC because of its shorter running time. The relative heating load of each design option is apparently as well defined by MICROPAS as by SUNCODE-PC.

Out of interest, building 1 was also modelled using DEROB. This run took 14 minutes (840 seconds) of logon time and predicted a yearly heating load of 31GJ. Because of the severely restricted output options associated with DEROB, we could not compare the losses or solar gains with the other programs without producing a very detailed hourly account of all the heat flows through all the energy paths (surfaces, infiltration, etc). It is this facet of its operation which restricts DEROB to be primarily used as a research tool (although some firms in South Africa have used it to design large buildings).

Although MICROPAS would be quite useful in the USA for comparing design options, it is not particularly useful in most other countries, because it only uses imperial units. In our experience, New Zealand designers would not want to go to the effort to convert their building dimensions, and the other parameters needed for the input file, into imperial units. Both SERI-RES and SUNCODE-PC are quite useful from this point of view, as they make provision for either type of units to be used.

A problem that was discovered with three of the programs (excluding DEROB), was that their developers did not realize the modelling requirements for the southern hemisphere. SERI-RES (and SUNCODE-PC) required modification of the FORTRAN code, and the MICROPAS documentation needed to be modified, before they were suitable for the southern hemisphere.

Again, all three programs require the user to determine what proportion of solar gain is absorbed by the air or a surface, without indicating (other than some sample values within the documentation) how the user should calculate these proportions. Also, from the documentation, MICROPAS appears to require different values as input than does SUNCODE, for the same building. DEROB however, actually calculates these values in one of its program modules, by determining the geometric relationship between each surface. It is because of extra features such as this that DEROB requires such a large machine, and takes so long to perform a simulation. As yet, we have not had the time to simulate buildings 2 through 6 using DEROB. This will enable us to compare the effect of DEROB's more rigorous determination of the distribution of the solar gains with MICROPAS's and SUNCODE's method of leaving this decision to the user.

SERI-RES and SUNCODE-PC allow the user to create libraries of data values of building elements that are used quite frequently, which can then be simply called upon, in any combination, when modelling a building. MICROPAS only allows one building file to be used to create each model, and is therefore more limited in its library capabilities.

The final problem that we would like to mention concerns the whole family of design tools in general. As yet, a common language has not been determined and agreed upon when describing thermal simulation concepts. An example of this is the "solar coefficient" (SERI-RES and SUNCODE-PC) and the "absorbed insolation fraction" (MICROPAS), both of which relate to the distribution of solar gain through glazing. We concede that coming to grips with these various terms is quite easy for researchers conversant in the field. However, the final user of these programs is not as fortunate, and once s/he has learned one language, s/he will be unlikely to want to learn another. We should not only be encouraging designers to accept thermal simulation programs as an invaluable aid in the design process, we should also encourage them to demand better standards of clarity and useability from these programs.

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Table I: Results of the Parametric Simulations

Building	Program	Results (GJ) Losses (A)	Gains (B)	Heating Load (C)	Utilized Gains (D) A - C	%'age of Gains Ut.	Time (s)
	SERI-RES	18	0	18	0	--	125
1	MICROPAS	20	0	22	-2	--	215
	SUNCODE	17	0	18	-1	--	1065
	SERI-RES	26	21	16	10	50	135
2	MICROPAS	30	24	19	11	45	305
	SUNCODE	25	26	15	11	41	1210
	SERI-RES	32	42	17	15	36	135
3	MICROPAS	37	47	14	23	49	305
	SUNCODE	32	52	16	15	30	1215
	SERI-RES	32	41	17	15	37	140
4	MICROPAS	38	44	14	23	53	305
	SUNCODE	32	51	16	16	30	1305
	SERI-RES	149	42	118	31	73	225
5	MICROPAS	308	47	73	234	500	685
	SUNCODE	141	52	112	29	56	2045
	SERI-RES	58	42	28	30	73	185
6	MICROPAS	101	47	56	45	96	380
	SUNCODE	59	52	25	33	64	1615

A Standard for Computer-Aided Design/Drafting (Construction)

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ABSTRACT

The recent move to automated technology by the construction industry has created a need for a consensus on symbology and presentation for computer-aided design/drafting before the majority of the community adopts the technology. A standard for computer-aided design/drafting would greatly assist the construction industry and the development of software in Canada and in the international community. Canadian Standards Association Committee B78.5 has developed a Canadian standard which applies to the computer-aided preparation and reproduction of construction drawings. In general context, it establishes the detailed recommendations on symbology and drafting techniques for computer-aided design/drafting in the construction industry. This paper introduces the standard, which will be published in summer 1986, and outlines the history of the standard, the requirement for standardization of computer-aided design/drafting, the goals of the standard, and the potential benefits for the construction industry.