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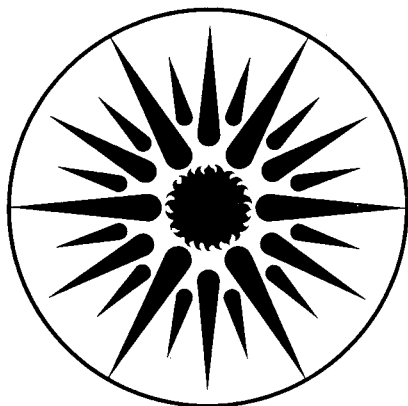## UNIVERSITY OF CALIFORNIA

APPLIED SCIENCE DIVISION

The COMIS Infiltration Model

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DISCLAIMER

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1. SYNOPSIS

The COMIS workshop (Conjunction Of Multizone Infiltration Specialists), using a multi-national team, is planning to develop a reliable, smooth running multizone infiltration model on a modular base. This model not only takes crack flow into account but also covers flow through large openings, single-sided ventilation, cross ventilation and HVAC-systems. The model contains a large number of modules which are peripheral to a steering program. COMIS can also be used as a basis for future expansion in order to increase the ability to simulate buildings. Small task groups were formed to work on particular problems in developing the modules. Each COMIS team member works on several task groups.

2. INTRODUCTION

The first COMIS *Newsletter* was send to colleagues almost three years ago to inform them about the joint research project being planned to develop a multizone infiltration model at Lawrence Berkeley Laboratory (LBL). Even though this kind of co-operation is well established in other fields of research, e.g., high energy physics, in the field of building physics it is new to engage in a research project which one individual or country would not be able to do alone. From the beginning the COMIS idea was well received. Owing to the diverse background of the group several national and international research programmes are co-ordinated with the COMIS workshop.

Special emphasis has been given to the input/output routines so that the final program should not only be "user-tolerant" but "user-friendly." It is being developed in such a way that it can be used either as a "stand-alone infiltration model" or as an "infiltration module" of a building simulation program. The input/output procedure is therefore being developed in such a way that either the COMIS input/output modules can be used or only the input/output interface. This makes it possible for the user to connect the program with other software (e.g., CAD-systems).

The input program section is subdivided into several separate modules with each of them requiring specific data. The modules will provide backup from data bases for default value input and for checking terminal input. However, these databases will not be filled extensively within the COMIS workshop.

The building description section will allow for a 3D repetitious input of wall elements to build up rooms, floors and complete wings of the building. Physical properties are then assigned to each wall. The program also allows for direct generation of the flow network.

One of the major tasks has been to find a method of determining the wind pressure distribution for a building according to measured data from available literature. This will allow building designers to work with the COMIS model even if wind tunnel results are not available for the building under consideration.

Crack flow, large openings and mechanical ventilation systems can be modelled by COMIS. Furthermore, additional flows which do not influence the pressure distribution in the network in a major way, i.e., simultaneous two way flow at large openings and wind turbulence effect at single-sided windows etc., are studied. The correction of coefficients of power law for crack flow, taking into account the effect of the temperature distribution of air in the crack is also studied.

Calculating the infiltration and ventilation flow rates requires the solution of a non-linear system of equations. The main task has been to find an efficient solving method. The starting point is the Newton-Raphson method which, in most cases, allows the system of equations to converge rapidly. The method is modified to avoid occasional convergence problems when working on power functions but in principle, it is a question of finding an appropriate relaxation coefficient. Most work done up to now concerns efficient linear methods. The special characteristics of the linear system of equations have been studied, and based on this, a direct method has been developed, timed, and documented. An iterative method is under investigation.

The aim of the experiments being developed in the COMIS project is to provide real data for multizone model validation. Two full scale experiments are planned. One will be performed by the EPFL group in Lausanne using the LESO facility, and the second is under way in the Bay area using a multizone house. This house has been used by the Radon group at LBL and is available for COMIS throughout the workshop.

A handbook will be written to describe ways of using the model and its physical background. It will describe the program structure and each of the modules in the COMIS library as well as the input and output of the program. Special emphasis will be given to the use of the model starting with the installation procedure and going on to describe how to connect COMIS with other programs (interfaces) as well as explaining the input. The input data set for a simple example will be included in the handbook.

The features of expert systems have been studied in terms of function, data structure, and development procedures. We found that most of the expert systems were developed for specific problems and are still prototypes in the research stage. They need to be further developed for practical use.

Applying the expert system to multizone infiltration would have many benefits to both users and researchers. A CAD system as a user interface to describe a building would be especially helpful in developing a user-friendly system.

3. STRUCTURE

3.1 General

Although plans for COMIS began in 1985 the need to think about the structure of the model in detail came up at the first COMIS meeting in Lausanne in the fall of 1987. To start a one year workshop with 8 participants offered the chance of creating the so-called "worlds best ventilation model". But selecting the best methods for input processing, data handling and calling routines and even defining the precise goals for the model easily could take months. Therefore, a proper common census program structure and a definition of the goals of the program became necessary.

3.2 Related processes

Ventilation, heat flow and pollutants are strongly combined in a building. In studies of ventilation processes, heat flows and pollutants are generally not allowed to be ignored. Most of the problems in buildings nowadays deal more with indoor air quality, energy and ventilation rather than with ventilation only and a connection is even made with sound, lighting and comfort. As occupants of the building can have a major influence on all these processes the effect of occupant behaviour also cannot be ignored. This pointed to the need to simulate all the physical processes in a building as precisely as possible in order not to exclude the possibility of combining the different phenomena.

3.3 Problem solving

The number of different problems to be solved using such a model requires flexible routing procedures. For example, a possible way to solve ventilation problems is well demonstrated in the "Air Infiltration Calculation Techniques" guide [1]. Depending on the desired degree of accuracy a multizone building can be simulated using a smaller number of zones in the COMIS program or even with a regression formula. The results of this can be re-diverted for instance, into the different flows required by the user. To make the correct decisions for routing the program and to check input and results, a "problem definition" and a data storage for "administrative control data" are necessary. An expert system is the obvious way to have flexible control of these processes but although Berkeley is world-famous for such systems the possibility of including one in the COMIS program appeared to be low. This is partly because of our need for a system that would be capable of handling graphics. As some of the COMIS participants will develop expert systems in the near future it was decided to develop the COMIS program without an expert system and later replace the "IF - THEN - ELSE" decision section with a rule base for the expert system.

3.4 Data

Data storage should be flexible in containing information about a building and its physical properties at almost any level of detail. As this includes full geometrical description of the building a CAD system would be preferable. As the code should be free of proprietary software the possibilities for including a CAD were referred to "later add-on's by the user". The input data for the program will include:

- Problem Definition
- Building
- Operation Schemes
- Environment
- Meteo
- Wind Pressure Coefficients
- Air Leakage Values

In order to be self-explanatory most of the data files will include text headers.

3.5 Features

One of the thresholds for an international program is the use of non-SI units. The program will operate internally with SI units but as the input allows for text headers these text headers will be interpreted to look for other units. The conversion factors will be looked up in a data store. Units mentioned for the results will be used to translate the output from SI into other units. A language text resource will be used for most input/output at the user interface. This allows for an easier translation into different languages.

3.6 Structure

The COMIS structure we now use includes schematic drawings of 87 modules and shows the relations between these and the major data flows. This is helpful in preventing flow chart errors in the program and in locating missing functions or routines. Besides this structure the list of parameters used in the main programs and the list of the prepared and finished modules is frequently updated.

4. INTERACTIVE INPUT PROGRAM

The input is given using seven different blocks, namely:

1) Problem Description
2) 3D-Building Description
3) Direct Network Description

4) Operating Schedules Input

5) Cp - Value Input

6) Environment Description

7) Meteo Description

The Problem Description Section asks for run control parameters and for the input type and then guides the user through the specific input modules.

The Building Description Section allows for repetitive 3D input of wall elements to build up rooms, floors and complete wings of the building. Physical properties are then assigned to each wall. The program also allows for direct generation of the flow network. A well defined interface for the geometric data will not only allow for the generation of simple graphic echo of the building geometry but also for a possible future linking to a CAD system.

Type as well as subtype definition are used to characterize airflow components. The description of these components relies on the airflow component database which can also be used for default properties data input providing, e.g., standard leakage values.

The format of the airflow component properties database is set up for demonstration purposes only and must be defined in more detail --considering already established databases (e.g., ASHRAE [2] or AIVC handbook [1]) as well as the results of ongoing research projects (eg. IEA-ECB Annex XX). It is therefore planned to add a database management module to the input program later on. This module also will include a routine for the polynomial description of fan components.

The Operation Schemes module allows for the input to, or for the assignment of, all kinds of schedule files or of parameters for program internal schedule-generators.

The Cp-Values module sets up the cp-value data for the specified facade elements including backup input from the database. As a special option a routine for the calculation of cp-values is available which is based on data given in the 3D building description and the description of the environment.

The Environment description asks for the non-time dependent surrounding parameters and the obstacles geometries. The Meteo Description module allows for input of weather data from the terminal as well as from separately generated weather data files.

A prototype version of the interactive input programme module has been established as described in the last COMIS Newsletter [3].

5. LARGE OPENINGS

5.1 General

Airflow rates through doorways, windows and other common large openings are significant ways in which air, pollutants and thermal energy are transferred from one zone of a building to another [4].

However in a previous review [5] of multizone infiltration models, made in 1985, none of the described codes were able to solve this problem in any other way than to divide the large opening into a series of small ones described by crack flow equations.

COMIS's contribution to this fundamental problem will be to describe the physical problem, review the various solutions developed in the literature and compare these solutions using both a numerical and a physical point of view.

5.2 Integration of Large Openings in a Multizone Infiltration Model

Basically, a multizone infiltration model like COMIS is defined by a network description of the pressure field in a building. The pressure nodes or zones are linked by non-linear resistances and the law of mass conservation in each zone leads to a non-linear system of pressure equations.

It is obviously possible to describe the behavior of large openings in two ways. Either one can describe the air flow rate through a large opening using a non-linear equation of the pressure drop or one must solve this singular problem separately and include the results as an unbalanced flow in the mass conservation equation of the described zone.

Both solutions are currently being investigated by COMIS.

5.3 Unbalanced Flow Approach.

The basic problem of instantaneous air transport through a large opening linking two zones with different air densities can be solved analytically in the case of an incompressible and inviscid flow in steady conditions by using Bernouilli's equation. In the case of an existing supply of air in one zone, or of different thermal gradients from both sides of the opening, a solution can also be reached by using numerical tools.

These solutions, based on a fluid mechanics approach, have been already developed by COMIS. They lead to the definition of an air mass flowing in both directions through the opening.

As natural convection is usually the main driving phenomenon another solution consists of using empirical correlations which give the total heat transfer rate through the opening as a function of its geometry and of the thermal state of each zone. The heat transfer can then be converted to a mass flow rate using calorimetry equations.

In the case of both solutions the large opening is disconnected from the general pressure network and is solved separately. It is then represented by an unbalanced flow in the mass conservation equation of each zone.

5.4 Introducing Large Openings in the General Network.

To connect large openings to the general network, one must define their behavior in terms of nonlinear equations of the pressure drop.

The first idea is to describe the large opening as a conjunction of parallel small openings. Each small opening is then described by a crack flow equation taking into account the local pressure drop, and the whole system of nonlinear equations can be introduced directly in the pressure network [6,7].

Another possibility consists of interpreting the flow equations given by the fluid mechanics approach in terms of pressure. This method leads to the definition of new flow equations in pressure characterizing the behavior of large openings.

All these elementary solutions are going to be tested and compared in order to define clearly the limits and the advantages of each one.

5.5 Unsteady Wind Effect and Turbulence

The general laws demonstrated by thermal or fluid mechanics approaches are also valid for large exterior openings in steady state conditions. But none of these methods enables us to quantify the effect of an unsteady wind or large scale turbulences.

Experimental results have shown that these effects can be particularly significant in the case of one-sided ventilation. Nevertheless very few correlations have been proposed and most of those that have concern particular configurations. It seems difficult, therefore, to introduce these effects in a general way in our first model. However, we will hope to do so later on as an improvement to COMIS.

6. CRACK LEAKAGE PERFORMANCE

6.1 General

The temperature of air flowing through a crack depends on the following factors:

- air flow rate
- air temperatures of the zones on both sides of the crack
- dimensions and form of crack

In most cases the temperature of the air in a crack is quite different from the temperatures of the the zones on either side of the crack. Furthermore, air leakage performance measurements are usually performed in a certain temperature condition but used at different temperatures. The temperature variation, however, has a big influence on the air leakage flow due to changes in the air viscosity and air density. Unfortunately, almost all the models dealing with air leakage characteristics ignore this phenomenon.

6.2 Crack Flow Equation

Data obtained from measurements on crack models show that, for turbulent crack flow, the mathematical description of the friction factor is identical with the one found for conduit flow with smooth walls. Therefore crack flow can be seen as duct flow with a more complicated flow path.

6.3 Correction Factors for Temperature Influence

We found from the crack flow equation research, that the flow performance is strongly temperature dependent. In order to arrange the results in the usual form we have introduced correction factors which account for the temperature influence. The correction factor depends on the type of leakage. We have developed three different equations for the different correction factors.

6.4 Crack Form and Air Flow Temperature

We can easily build an air leakage temperature module according to the crack forms. Fortunately, we found that the crack form mainly depends on the structure of the building or on the type of building component and that its size depends on the workmanship. We therefore classify crack forms into three groups: double frame windows, single frame windows and doors, and walls.

6.5 Crack Types

Double Frame Windows

The air passing through the window unit is well mixed with the air contained in the space between the two frames. The air temperature depends on the flow direction, flow rate and window structure etc. The air leakage temperature is assumed to be the air temperature in the air space of the window.

Single Frame Windows and Doors

The air has only a very short distance to pass through the crack and therefore, the influence of the crack surface temperature is quite small. Most of the air flowing through the crack does not come from the well-mixed part of the zone, but from the boundary of natural convective heat transfer. The air leakage temperature is therefore assumed to be equal to the boundary air temperature at the high pressure side of the flow path.

Walls

The form of cracks in a wall can be divided into three groups. Straight cracks, whose flow length is approximately equal to the thickness of the wall, belong to the first group. The second group covers labyrinth cracks in which air travels a long distance before it leaks out. A typical example of this type of crack is the air space wall. The third group covers walls in which air leaks homogenously through the wall. We have established the physical and mathematical models for all three crack forms but up to now use only the equation formulated for the third

group.

7. HVAC SYSTEMS

7.1 General

HVAC-Systems (Heating, Ventilating and Air-Conditioning Systems) are composed of ducts, duct fittings, junctions, fans, air filters, heating and cooling coils, air-to-air heat exchangers, flow controllers, etc. Several of the program modules concerning ventilating systems have already been developed allowing us to calculate the coefficients of the flow equation for duct works with fittings, the static pressure losses for T-junctions and the volume flow rate of a fan as well as for a flow controller as a function of the pressure difference.

7.2 Flow Coefficients for Ducts

This module calculates the flow coefficients of the flow equation for ducts including duct fittings. The flow coefficients C and n are calculated using the following procedure:

1) An estimated volume flow rate through a duct is given as input data. If the flow is in the turbulent range the duct friction factor is calculated by an approximate explicit equation from Moody (instead of the Colebrook equation, which is an implicit expression). If the flow is in the laminar region the duct friction factor is calculated dividing a constant by the Reynolds number. In the transitional range the factor is taken as an interpolated value between the two transitional points. The pressure loss along a duct, including dynamic pressure losses through duct fittings, is calculated.

2) In order to obtain the flow coefficient and the pressure exponent the pressure losses for an alternative volume flow rate are automatically calculated in the module. That value of the flow is 10 % higher in the turbulent range and 10 % lower in the laminar range than the initial value.

3) The flow coefficient of C and n are obtained by the straight line connecting the two points plotted on a log-log chart. The exponent is given by the slope of the curve. The exponent n and the initial values of the flow rate and the pressure difference determine the coefficient C.

7.3 Static Pressure Loss at T-junctions

Since the duct systems are described by a network in the air flow model the junction is treated as a pressure node. Input data are the three volume flow rates through the three ducts which are connected at the junction as well as the static pressure at the point in a duct just before the junction. The output are the static pressures at the two points in the two ducts just after the junction.

There are some data available in the literature for the pressure loss coefficients at the T-junction. We obtained data from the ASHRAE Handbook of Fundamentals [2], German handbooks [8,9], the final report of IEA-Annex X "System Simulation" [10] and the Dutch building standard [11], as well as a Japanese research paper [12]. To our surprise we found that the values of the pressure loss coefficients were significantly different according to the sources. For example, in the case of converging flow, the pressure loss coefficient through the main duct of the T-junction obtained from one source is double the value of the loss coefficient given in another.

As a first step we use the data prepared by Ito and Imai [12], since all six pressure loss coefficients for the four possible cases of flow patterns at a T-junction are expressed by empirical equations. Furthermore, his values are close to the values presented in the ASHRAE Handbook.

7.4 Fan Performance

The fan performance curve is expressed on the basis of more than three data sets of the volume flow rate and the pressure difference, by the polynomial approximate formula using the least square method. If the pressure difference is outside the normal operation range the fan performance is expressed by the straight line connecting the two points which show the maximum pressure difference and the minimum pressure difference in the normal operating range. Input data is a pressure difference; output is the volume flow rate calculated from the fan curve.

A module has also been prepared for correcting the fan performance due to the air density.

7.5 Flow controller

The pressure loss curve is expressed by equations based on data sets of the pressure loss and the volume flow rate. The input data is the driving pressure difference of the flow controller. The output data is the volume flow rate.

There are other components connected to the HVAC-Systems which cause dynamic pressure loss, e.g., air filters, heating or cooling coils, different types of junctions, etc. The calculation procedures for these components will be added as soon as possible.

8. WIND PRESSURE COEFFICIENTS

8.1 Evaluation of The Surface Pressure Coefficient

The pressure distribution around a building is usually described by a dimensionless pressure coefficient (Cp), which is the ratio of the surface pressure and the dynamic pressure in the undisturbed flow pattern, measured at a reference height [13].

Wall averaged values of Cp usually do not match the accuracy required for air flow calculation models. More detailed evaluations, taking the Cp distribution on the envelope of buildings into account, can be made in different ways:

- performing full scale measurements when an existing building is being studied

- carrying out wind tunnel tests on models of existing buildings or buildings in the design stage

- generating Cp values by numerical models based on parametrical analysis of wind tunnel test results

The first way is pratically impossible to follow unless done within expensive and time-consuming experimental plans. The second way depends too much on the availability of test equipment and relevant assistance. The third method seems to be the only one assuring easy and wide data access.

Recently, some research has been carried out in this direction (Swami & Chandra [14]) but a lot of work remains to be done, mainly in improving the experimental knowledge of the phenomenom.

8.2 Parametrical Analysis on Pressure Coefficients

In order to calculate the Cp-distribution for buildings we are working on a method based on a parametrical study, to determine the Cp-values. The available methods have been checked by comparing calculated results with findings from wind tunnel tests found in the literature. Since the results did not match the data well, a parametrical analysis of wind tunnel test data, aimed at developing a calculation model for Cp-data, has been carried out.

To find a set of data large enough to cover a wide range of parameters affecting the variation of Cp, several wind tunnel test reports have been considered. Two tests have been chosen as references: Hussein & Lee [15] and Akins & Cermak [16].

We have taken as reference the center line Cp vertical profile of the Hussein & Lee cube-shaped model for wind direction normal to the wall with no surrounding obstacles and at a height equal to the height of the surrounding roughness elements in a low density urban area. Several CP data sets from the tests have been analyzed. The relevant variations at different relative model heights were normalized with respect to the reference profile.

Each data set has been related to a specific parameter among the following:

- Velocity Profile Exponent, characteristic of the roughness

- Plan Area Density, representing the density of surrounding buildings

- Relative Height, ratio of model height to height of surroundings

- Aspect Ratios, model length or width to model height

- Wind Direction Angle, measured from the line perpendicular to each wall
- Relative horizontal position of the point being looked at

Data curves have been fitted in relation to each parameter in order to obtain polinomial equations. Correction coefficients for reference Cp were found. A routine to calculate surface pressure coefficient values at any point on the wall has been developed.

A test of the routine has been carried out by comparing calculated results to Cp values from the reference data sets. The comparison shows the method to be reasonable accurate within the limits of the application and the consistency of the data sets themselves. A comparison with other authors has not been carried out as yet because of lack of data.

In addition to the detailed calculation module a simpler module dealing with wall-averaged Cp values from AIVC data sets [1] has yet to be developed.

9. SOLVER

A building is basically modelled by pressure nodes that are interconnected with air flow links. For one time step, the outside of the building is represented by a fixed boundary condition. The pressures of the internal nodes in the air flow network have to be solved so as to determine the different air flow rates. Solving these infiltration and ventilation flow rates requires the use of a non-linear system of flow equations. The main task was to find an efficient and stable method.

The starting point is the Newton-Raphson method, with derivatives, operating on a node-oriented network which, in most cases, quickly brings about the convergence of the system of equations. The method has been modified to avoid occasional convergence problems when working with power functions. Fortunately, the origin of the convergence problems is well understood. The solving method is working on the flow balance equations and not on the flow equations. If one or several of these balance equations have an exponent close to one-half the Newton-Raphson method will not work well due to the nature of the procedure, in finding the next approximation. One instance when this happens is when a leakage opening with a flow exponent of one-half is predominant in one zone. In this case the flow balance equation will also have an exponent close to one-half. An under-relaxation will increase the convergence velocity and bring us to the solution. In principle it is a question of finding an appropriate relaxation coefficient.

Three methods were tested. First, a constant under-relaxation coefficient can be used for all flow balance equations if the iterations converge only slowly. This is the simplest approach. This method does not require any calculations in finding the coefficient and a coefficient close to one-half is expected to solve the system acceptably. The disadvantage of this method is that the convergence is slow and probably unstable. Because of this no further work has been done using this approach. As a comparison a conventional Newton-Raphson method is used.

Second, a separate under-relaxation coefficient can be used for each flow balance equation. The coefficients are determined as an extrapolation from the two preceding iterations. The main disadvantage seems to be that each coefficient is determined without dependence of the other coefficients. The convergence velocity can therefore not be expected to be optimal. However, the amount of work in determining the coefficients is relatively limited which may speed up the method.

The third approach is more systematic. The problem of finding a relaxation coefficient is considered to be an optimization problem. The coefficient that causes the system to converge fastest is chosen. Therefore, only one coefficient for all zones is used. The disadvantage is that relatively considerable work is required to find the coefficient in each iteration. This method is expected to be very stable.

Furthermore, the derivatives are not defined if the pressure difference across an opening is zero. The closer the exponent of the flow balance equation is to one-half the higher is the risk for an overflow in the computer when the pressure difference is close to zero across the predominant opening. If an efficient relaxation method is used these problems may eventually arise but they can be avoided in several ways. The function can be linearized at this point. Another possibility is simply to disregard links with a very small pressure difference. Neither of these modifications is expected to change the result significantly. The former method has been implemented into the COMIS-code.

In each step of the iterative method a linear system of equations has to be solved. The special characteristics of the linear system of equations have been studied and the most important of these, as long as the matrix is not singular, are the symmetry and positive definiteness of the Jacobian matrix.

In the light of these studies a direct method, based on the Cholesky's method modified for band matrices, has been developed, timed, and documented. The Cholesky's method consists, in essence, of two parts. The first is the decomposition of the matrix into two triangular matrices. The second is the backward and forward substitutions of these matrices. The method does not require pivoting and only the lower triangular matrix has to be calculated during the decomposition. The method has been modified in such a way that band matrices can be handled efficiently and the band feature avoids unnecessary calculations with zero-elements. In a similar way the method can be modified using the skyline approach. The latter modification limits the work even more. If no unique solution exists, due to the modelling or round-off errors, the routine determines where the singularity is located in the matrix.

A direct method may run into calculation time problems for a poorly-structured matrix, i.e., large band width. It may be interesting to study methods which renumber the nodes in such a way that the band width decreases. If the matrix is large and has a poor structure an iterative method is probably the best choice. An iterative method was therefore originally planned to be integrated into the solver but due to convergence problems for a tested algorithm, this work has been cancelled.

The solver consists of about 10 subroutines and two steering programs. The modular approach makes it easy to exchange modules. The linear solver has its own steering program which can be exchanged entirely. The modular approach makes it also very easy to put several modules in parallel. The most efficient routine can therefore, be selected for every situation, e.g., different linear solvers.

Four basic networks have been selected for making a comparison between the different solvers. The smallest is a 2-node network and the largest is a 45-node network. All solvers have been tested regarding number of iterations and time required to reach the solution. The main result is that the optimized method requires about 40% less iteration steps than a method with extrapolated relaxation coefficients. However, finding an optimal under-relaxation factor requires twice as much work as a conventional Newton-Raphson iteration. Therefore, the total time for the two solvers is, in average, about the same. It has been decided to implement the optimized method in the COMIS program because of the fewer number of iterations required to reach the solution. This characteristic implies a more stable routine.

The linear band-solver is, in average, 30 times faster than an ordinary Gaussian solver for the most complex network used in this study. The sky-line solver is about 60% faster than the band solver. Although the time spent in the linear solver, in general, represents just a small fraction of the total CPU-time for a program, the sky-line approach has several advantages and was therefore chosen for inclusion in the COMIS-program.

10. FOLLOW UP OF COMIS

Work on the COMIS program will certainly not be finished by October 1989. A computer code will be available but such a program is ever perfectible. The validation procedure itself is a huge work and may not be completed during the COMIS year. Moreover, new knowledge will be available after 1989 which will be integrated into this program.

A roundtable discussion between the COMIS participants and the COMIS review panel about future perspectives revealed a strong feeling that COMIS (or its successor) ought to operate as an international institution with participants committing themselves to a definite work load.

It was questioned, whether COMIS should be attached to an existing IEA-Annex or be an IEA-Annex on its own. The attachment to an existing annex is critical because of the time frame. Annex XX, which would be the most likely candidate for a merge, is already in the second year of its 3 1/2 year existance. Annex V is not a task shared annex; work is performed by AIVC's staff in Britain.

Whether the Executive Committee of the IEA would support the installation of a new air flow related annex could not be answered during the discussion. AIVC's operating agent was asked at the steering group meeting in April 1989 to outline the possible interactions with COMIS at the June ExCo meeting. Following the September steering group meeting the operating agent will bring a firm proposal

to the December ExCo meeting.

In order to keep the momentum alive Lawrence Berkeley Laboratory plans to continue to work on multizone infiltration modelling for the upcoming fiscal year. If there is a positive response from the ExCo, this could include taking the steps necessary to get an international working group together.

The following list outlines the tasks to be performed by a COMIS successor:

- additional work on pressure coefficients
- additional experimental studies (flow data from a structure in a controlled environment as well as parametric studies of wind pressure distribution around buildings)
- generation of occupant's behaviour
- implementation of new knowledge
- HVAC-Performance
- data bases for material, leakage characteristics, absorption, desorption
- sensitivity study to reduce input requirements
- expert system
- zone to zone ventilation effectiveness
- simulation in time
- back draft problems
- **INPUT-features:**
  - language text resource for user interface
  - unit translator
  - subsidary modules that act on the input
  - adjust building leakage to measured data
  - input check on data and problem definition

- **OUTPUT-features:**
  - subsidary programs at output
  - dosis of occupants
  - origin of air
  - typical pressure distribution in time across building parts
  - comparison of different runs for one building
  - comparison of ventilation with demanded values in standards
  - check for comfort, safety and sound of pressure differences across cracks, windows and doors

11. ACKNOWLEDGEMENT

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