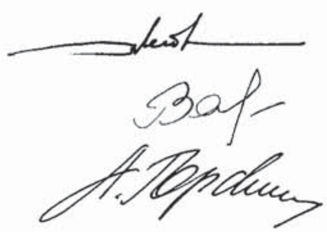
The more complex designing sections (calculation and erection diagram elaboration), requiring a lot of maschine resources and implementation of a high speed computer are being performed on the models EC and ones less complex sections (individual elements designing) can be performed on the models CM.

During the TDL KALIPSO elaboration the experiences of the AS LIRA elaboration were used in a wide scale. The certain AS sections and modules were included as components in the TDL. The inicial data also are preset in a compact and habitual for an engineer form on the special blanks. On a level with presetting of the inicial data from a different media are also being used the alphanumeric and graphical displays coder. There is a developed system of automated error diagnostics, visual control on the plotter or graphic display of the data presetting.

The TDL KALIPSO application provides a further (in respect of the AS LIRA using) elevation of the efficience of designing of engineering objects.



UTILIZATION OF DECISION MODELS UNDER UNCERTAINTY FOR THE ANALYSIS OF BUILDING ENERGY SIMULATION RESULTS

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KEYWORDS

Energy analysis, building design, decision making, uncertainty, passive solar

ABSTRACT

In current energy analysis techniques, usually a deterministic relationship between the weather conditions and the building thermal loads is assumed. In passive system applications, the thermal behavior of a building could be better analyzed if uncertainty related to weather conditions is taken into consideration. In this paper, different design alternatives of an office building in Montreal are evaluated using a research oriented software developed at the Centre for Building Studies. The simulation results are analyzed using decision models under uncertainty. The best design is defined to provide the minimum thermal load and the thermal comfort within acceptable limits. The results indicate that the attached unheated solarium on the south wall reduces the space load by 40% with respect to the conventional design.

L'UTILISATION DES MODELES DECISIONNELS EN ETAT D'INCERTITUDE DANS L'ANALYSE DES SIMULATIONS DE LA CONSOMMATION ENERGETIQUE DES BATIMENTS

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MOTS-CLÉS

Analyse énergétique, conception de bâtiment, décision en état d'incertitude

SOMMAIRE

Dans la pratique de l'analyse énergétique des bâtiments, on considère habituellement la relation déterministe entre les conditions climatiques et les charges thermiques. Le comportement thermique des systèmes passifs pourrait être mieux analysé si on considère l'incertitude dans la prédiction des conditions climatiques. Dans cette communication, on présente la simulation des différentes solutions d'un bâtiment de bureaux à Montréal, en utilisant un logiciel développé au Centre des études sur le bâtiment. Des modèles décisionnels en état d'incertitude sont utilisés dans l'analyse des résultats. La meilleure solution doit assurer les charges thermiques minimales et le comfort thermique à l'intérieur. Les résultats indiquent qu'un solarium nonchauffé sur la façade sud diminue la charge thermique de 40% par rapport aux solutions conventionnelles.

1. INTRODUCTION

Usually, the building energy analysis programs use the weather data for a reference year or for an average design day, to estimate the building thermal loads. Instead of using the deterministic relationship between the weather data and the building load, as implicitly defined by this procedure, a probabilistic approach is used in this paper to take into consideration the uncertainties in predicting the climate. The effectiveness of the implementation of passive solar design alternatives to large office buildings in Montreal is analyzed, using decision models under uncertainty.

2. DESIGN ALTERNATIVES

The analysis was performed for south facing, intermediate level room in a large office building in Montreal. The 100% elimination parametrics procedure (1) was used to identify those parameters with a significant effect on thermal loads, and then to establish the design alternatives. The daily thermal load was computed for a base case (Table I) on December 25, 1979 to be 0.44 kWhr/(m^2 day). Then this thermal load was compared to that of cases where a building parameter was eliminated (Table II). Since the solar radiation has an important effect of 160% on the thermal load, several design alternatives were considered such as: increase in the window size, increase in the building mass, larger room temperature swing, better insulation of windows and the introduction of an attached unheated solarium. The following parameters were considered in the analysis, for the two main categories of design alternatives:

2.1 Conventional Design

Windows - glazing to wall ratio: 0.5, 0.8, 0.99
- U-value: 1.3, 2.6 (W/m^{2}C)
- night insulating shutters reducing U-value by 50%

Interior mass - medium (380 kg/m^2 floor area) and heavy (510 kg/m^2) floor area

Office air temperature - 21 ∓ 0.2°C, 21 ∓ 1°C, 21 ∓ 2°C, 22 ∓ 2°C

2.2 Attached Unheated Solarium

Windows - U-value: 2.6, 6.2 (W/m^{2}C)
- night insulating shutters reducing U-value by 50%

Interior mass - heavy (570 kg/m^2 floor area) and very heavy (1000 kg/m^2 floor area

Office air temperature: 21 ∓ 0.2°C

3. DECISION UNDER UNCERTAINTY

The weather conditions for seventeen individual days in December 1979 in Montreal (2) were considered as possible futures with unknown probability of occurrence (Fig. 1). A systematic evaluation of all alternatives under the possible futures has been performed to estimate the hourly and daily heating/cooling load and the thermal comfort index. This evaluation uses a research oriented program (3) based on heat balance method and finite difference techniques. The objective of the analysis is to select best design alternatives which provide minimum space load under these uncertain futures. In the first step, a decision model based on the aspiration level criterion was used to eliminate those alternatives providing thermal discomfort or very high space loads. In the second step, the decision analysis was applied to the remaining alternatives using:

a. Laplace criterion, based on principles of insufficient reason which assumes equal chance of occurrence for each future.

b. Hurwicz criterion, where the preferred design alternative respects the following condition:

$$\min_{i} \{(i - \alpha) \max_{j} L_{ij} + \alpha \min_{j} L_{ij}\}$$

where

α - index of optimism, $o \lesssim \alpha \lesssim 1$
i - index of design alternative
j - index of possible future
L_{ij} - space load in the case of alternative i, under future j

Those design alternatives providing thermal loads within 10% of absolute minimum are selected as the best solutions.

4. DISCUSSIONS OF RESULTS

The difference between the space loads (Fig. 2) for sunny (December 24) and cloudy day (December 30) indicates some design alternatives are more sensitive to weather conditions, such as large windows and/or small room temperature swing (A3, A12, A16). The best design alternative (attached unheated solarium A19) reduces the space load by 40% with respect to the best conventional design, for α = 0 to 0.75, that is for a large range of possible weather conditions. For the most pessimistic conditions (α = 0), the best conventional design has smallest and best insulated windows. For α = 0.25 to 0.75, the solutions require large and well insulated windows. For the most optimistic conditions (α = 1), several solutions provide no heating load, but the attached solarium increases the cooling load.

5. CONCLUSIONS

The analysis of passive design alternatives for an office building, using decision models under uncertainty under the stated conditions shows that an attached unheated solarium on the south wall with 50% double glazing reduces the thermal loads by 40% on a December day in Montreal.

Since the analysis based on design day provides only the first insight, additional work is required to analyze the succession of several different days and, also, new design alternatives.

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Table I. Base Case

Intermediate level room	6 x 6 x 3.6 m
Exterior wall	South 0.10 m concrete, air cavity, 0.10 m insulation, 0.02 m gypsum board glazing to wall ratio = 50% shading coefficient = 1 window U-value = 2.6 $W/(m^2 °C)$ night insulating shutters
Interior walls	0.10 m brick
Floors	0.15 m concrete
Air infiltration	1.0 ach
Room air temperature	21 ± 0.2°C
Adjacent rooms temperature	21°C
Occupancy	9:00 a.m. to 18:00 p.m.
Internal heat gains	people = 10 W/m^2 lights = 20 W/m^2
HVAC system on continuous operation	

Table II. 100% Elimination Parmetrics

	Daily load (kWh/m^2 day)	Difference (%)
Base case	0.44	--
No internal gain	0.7	67.2
No solar radiation through windows	1.15	164.3
No conduction through glazing	0.15	65.0
No conduction through walls	0.31	29.2
No air infiltration	-0.72	263.7

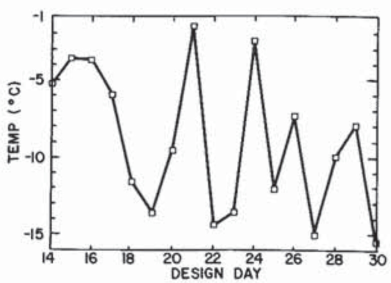

FIG. 1 Average outdoor temperature, Montreal, December 1979

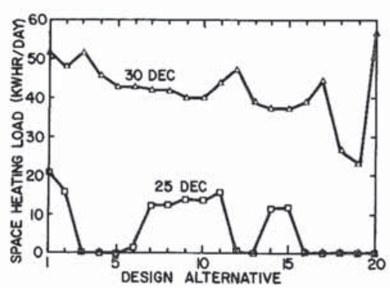

FIG. 2 Sensitivity of the design alternatives to weather conditions

Automatization of Calculation of Foundations on the Basis of Static Sounding Data

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KEY WORDS

Pile Foundation, Computer Programme, Shallow Foundation, Static Sounding, Modulus of Soil Deformation,Geotechnical Profile.

Computer programmes are proposed to calculate pile bearing capacity on the basis of static sounding data at every sounding point in a broad range of possible depths of driving. Apart from this it facilitates the choice of correct type of pile driving hammer and the definition of the necessary pile impact strength. Inaccuracy in calculations is compensated by correction coefficients established for each building site on the basis of control testing and results of previous experiences. The programme algorithm is based on the Bayesian formula.

Based on sounding data computer constructs geotechnical profiles which represent a system of isolines separating various zones in accordance to soil characteristics, with allowances for linear variation of basic indices.

For calculating foundations on natural bases dependences obtained experimentally are used which relate sounding data with permissible values of pressure on soil. Computers construct numerical models of a soil massive on the basis of calculated characteristics in the form of geotechnical profiles along the axes of a building and based on these models the dimensions of foundations at given loading are calculated.

The elaborated approach decreases the time necessary for soil investigation and design from 1,5 to 2 times.