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SOLAR DATA FOR BUILDING DESIGN IN NIGERIA

NIGERIAN BUILDING AND ROAD RESEARCH INSTITUTE

Foreword

The architect requires various solar data for the design of functional buildings which protect their occupants from the adverse effects of solar radiation. Solar data for the tropics are not easily available locally because such data are contained mostly in publications by overseas research organisations. They are also available in a limited extent in one or two textbooks on tropical architecture. This situation puts a serious constraint on architectural practice in Nigeria. To remedy the situation for Nigerian architects, the Nigerian Building and Road Research Institute undertook the current exercise whereby comprehensive solar data are computed for general use.

This report presents tables and charts of solar positions defined in azimuths and altitudes at different times of the day, and different days of the year for places situated at different latitudes in Nigeria. The concept of shadow angles and their application for the determination of shape and size of external louvres for shading windows is discussed. Tables of sunrise and sunset times, change over times for vertical walls and duration of possible sunshine on horizontal (roof) and vertical (wall) surfaces are provided. The method of conversion from solar time to standard time is presented. The method of calculating solar radiation incident on building facades of different orientation is briefly described, with typical examples provided where necessary.

This report will be found invaluable not only by architects but also by engineers, town planners and scientists involved in building design and research.

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1. INTRODUCTION

The main purpose of buildings is to protect the inhabitants from the vagaries of external climates. In a country like Nigeria with hot climate and high incidence of solar radiation almost throughout the year, it is particularly desirable that careful consideration be given to building design in relation to sunlight and shade. For this purpose, a variety of solar data may be required in readily usable form by architects, town planners and building scientists. The aim of this technical report is to provide calculated data on variation of solar positions, shadow angles, duration of sunshine on horizontal roof and vertical wall surfaces and solar loads for Nigerian latitudes in the form of tables and diagrams wherever necessary.

Solar positions defined in azimuths and altitudes at different hours of a day and different days of a year covering Nigerian latitudes are presented both in tables and charts in this report. These are useful in fixing the position of different rooms, walls and windows of a building in relation to the sun at different times. The determination of horizontal and vertical shadow angles and design of external shading devices like louvres is also discussed. The use of the data presented is illustrated with examples where necessary.

The possible duration of sunshine on horizontal roof and vertical wall surfaces on different days of the year for latitudes covering Nigeria is tabulated and presented. A quantitative assessment of solar radiation on building facades (roofs and walls) could not be included in the present report due to non-availability of design solar radiation values. These values are very essential for quantitative analysis of heat transfer through building fabric and for determining the effective insulation to be provided wherever necessary. But attempts will be made to incorporate this information in the revised report in the near future. However, calculated data on extraterrestrial daily solar insolation is included for practical estimation of solar radiation on the earth's surface.

2. MODERN ARCHITECTURAL TRENDS AND SOLAR CONTROL IN BUILDINGS

A recent trend of architectural development is the use of large expanses of glass in both office and residential buildings. There are many advantages of this development from the point of view of complete visual ease with the interior surroundings and the healthy psychological reaction asscciated with the sense of openness and the freedom that is engendered by large glass areas. However, extensive use of glass must necessarily call for judicious sun control. Where the main concern is the elimination of solar heat as is invariably the case in all parts of Nigeria, the most effective way is to block the direct rays from sun before they can pass through glassed areas. The glass itself readily permits a considerable proportion of the sun's radiant heat to pass through it into a house but acts as a barrier to the escape of this heat once it has been absorbed by surfaces within the house. However, with the knowledge of different solar data much can be done in the planning and design stages to effect a degree of control which will either eliminate the need of internal screenings as blinds or minimize their use. The factor which may enter into this problem are the siting, orientation and general arrangement of the building, the positioning of openings in external walls, and the placing of structural projections (balconies, canopies, overhangs, sun-break, walls etc.) and finally the special sun control devices, e.g. fixed or movable horizontal or vertical fins, louvres, trees and creeper, covered arches etc. By careful analysis of sun's orientation at different times of the day and year in relation to these factors, one is usually able, from the very start of the design of a building to introduce means for limiting the sun's impact when its presence is undesirable.

3. THE SUN'S APPARENT MOTIONS

For proper understanding of the data presented here, it is important to have a clear picture of the apparent paths followed by the sun in its daily movement across the sky. For convenience, we may imagine the earth to be stationary and that we see the ground about us as a cicular plane of indefinite radius bounded by the horizon. Also, if we conceive the sky as being some hemispherical shell completely covering the plane on which we stand, then the sun during the course of a day will appear to move along the arc of a circle which is symmetrical about the vertical plane, running north and south through the observer's position as shown in Fig. 1. At the solar noon, the sun lies in this vertical plane and occupies its highest angular position above the horizon for the day. This motion of the sun is made apparent because of the earth running daily on its axis of rotation.