Lecture

Daylight Measurement Data required for Daylighting Calculation

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Why should we collect daylight measurement data ? One of the most important purpose of the collection is to use for daylighting calculation. The calculation can be classified to two, (A) for the research and (B) for the practical application. Since it is difficult to predict at present time what kind of research we do in future and to specify a class of measurement data for above research, we have to collect and store only basic or typical data of daylight source as uncooked materials. Therefore, only the data for practice are considered in this lecture. The following figures show flow charts of various practical daylighting calculations, which are introduced from "Daylighting Calculation Method" to be published by the Architectural Institute of Japan soon.

1. Basic and simple calculation (Fig.1)

Fig.1 shows a basic flow of calculation of daylight factor or daylight illuminance. Of course daylight factor is defined as a ratio of an interior illuminance to the exterior horizontal value from unobstructed sky, and it only can be available in case of no sunshihe. The most simple calculation is the case of uniform sky or the case on the assumption that sky in the window seen from the reference point is uniform. This case is not related with the general measurements and data. The other following cases include more or less undecided questions using data.

2. Calculation for satisfaction of minimum criterion (Fig.2)

In this case the CIE Standard Overcast sky is used for the calculation. However, probability distributions (frequencies) and avarage values of the horizontal illuminance from unobstructed sky or the zenith luminace to eash solar altitude and cloud-type are insufficient. Therefore, those data are wanted. Furhermore, effects of ground reflctance on the sky luminace distributions is not sufficiently clear.

Fig. 1 Basic calculations of daylight illuminance and daylight factor

Fig. 2 Calculation if minimum criterion is satisfied or not

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3. Calculation using the Mean Sky (Fig.3)

This is a statistical prediction of daylight environment in interior proposed by Dr.H.Nakamura et al. In this method the daylight source is the Mean Sky without the direct sunlight for simplicity. The Mean Sky introduced by Dr.H. Nakamura et al. is a sky which the time-average luminance of a sky element is defined for specified duration (usually, sum of working hours) throughout a typical year.

In order to compose this sky it is necessary to know frequencies and averages of luminance distributions and zenith values of clear, intermediate and overcast skies. At the same time relations between probabilities of occurrences of these three basic skies and relative sunshine durations have to be obtained in use of a tentative method of composing mean sky proposed in CIE TC 3-09 Technical Report (draft). This method itself should be also checked by measurement

data.

4. Calculation including the direct sunlight (Fig.4)

We sometimes want to know a daylight illuminance in interior included the sunlight even instantaneous value from window with Venetian blind, vertical louver, special specular louver or light shelf receiving the direct sunlight. So, a measurement result of the direct sunlight illuminance corresponded with the turbidity factor is requested on the same aperture angle condition defined internationally.

5. Calculation for an evaluation of quality (Fig.5)

In order to inspect a silhouette effect, discomfort glare or reflected image on a CRT screen caused by window a limitation of sky luminance through the window is required.

Fig. 3 Calculation for statistical prediction and evaluation of daylit environment

Fig. 4 Calculation considering effect of direct sunlight

Fig. 5 Calculation for evaluation of quality of daylit environment

Fig. 6 Combining with air-conditioning load calculation

6. Combining with air-conditioning load calculation (Fig.6)

For a purpose of evaluation of saving electric power by daylight use we have to calculate continuously an instantaneous daylight illuminance on the reference point in interior. At the present time outdoor daylight illuminances are obtained from the solar irradiance data for the air-conditioning load calculation using visual efficiency, but this method leaves some problems.

In this method the original data is only horizontal global irradiance which has been easily obtained from many meteorological observatories in the world and the value can be theoretically separated into the direct solar component and diffuse one. Since the accuracy of this method is not satisfactory, simultaneous and separated measurements of above three irradiances and also three illuminances corresponded with the formers will be expected to become evident mutual relations between these six values.

Moreover, it is desirable to show clearly relationships between the sky luminance distributions, specially the intermediate sky one, and cloud amount, cloud type and relative sunshine duration (which is obtained from routine works at many weather stations).

7. Relations to data from the IDMY

If research class measurements in the IDMY (International Daylight Measurement Year) during several years since July 1991 is successful, above mentioned data will be gotten and analyzed to make necessary materials for various daylighting calculations. However, it is very difficult to measure automatically cloud amount and cloud type. Then, we have to use our brain and devise another method.

Furthermore, a collection of measurement data for the ground reflection will be an important future research subject, even if the IDMY program will be successful in the collection of data.