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Loadings on Buildings

Les charges sur les bâtiments

Lasten auf Bauwerke

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INTRODUCTION

The choice of an appropriate structural form and the design of the selected structure from the point of view of its strength, deformation, and structural stability depend on a knowledge of three things: the loads that it will have to carry, the properties of the materials of which it will be constructed and the structural actions by which the loads are transferred through these materials into the ground. It is notable that in the past the amount of research effort devoted to a study of loadings on structures has been only a fraction of that devoted to the other two aspects of structural design. This is all the more remarkable because, to the extent that economy of construction is a factor of any significance, the seeking of worthwhile improvements is just as valid in the field of loadings as it is in the fields of materials and structural actions - and no doubts have so far been cast on the latter.

One reason for this relative failure to apply research methods to loadings has been undoubtedly the difficulty, inconvenience and cost of the actual surveys, as compared with work on testing materials and research into structural behaviour. An even more fundamental reason has perhaps been the traditional attitude of not departing from an established system in the absence of any rational basis for, and consistent means of estimation of, structural safety. Consequently, designers and code committees have been able to use only limited and perhaps ad hoc measurements of loads, unguided by any comprehensive philosophy.

With the appearance of load-factor methods of design with their change of emphasis from the permissible stresses to the loads, and particularly with the advent of the concept of probability applied in a scientific manner (rather than unconsciously) to loadings, errors and approximations in design, properties of materials, and safety factors, there is now a greater awareness of the need to carry out a series of surveys of different types of building occupancy with a view to determining the actual loads that are applied to the structure, expressing them as a frequency distribution, rather than attempting to estimate so called 'maximum' loadings.

The general problems of loads, resistances, and safety parameters have been considered by individuals and by a number of national and international organisations, notably CEB and CIB. The major results of this have been (1) a general philosophy of safety (2) a number of theoretical statistical analyses of safety or reliability using assumed, and sometimes actual, distributions of load intensities and resistances (3) an attempt, by a consortium of international organisations, to standardise, through ISO, the definitions used in the philosophy, and (4) a draft ISO recommendation for occupancy loads - this latter based only on an integration (Ref. 1) of existing national codes with a view to their incorporation in the new design method.

SOURCES OF LOADING

The sources of loadings on buildings may be considered to fall into two groups - the geophysical and the man-made.

The geophysical loadings consist of gravitational, meteorological, seismological and magnetic effects that depend partly on the mass, size, shape and materials of construction of the building and its contents and partly on the 'field strength' of a number of naturally occurring influences e.g. the gravitational field, the velocities, temperatures and humidities of the air, the seismological accelerations and frequencies, and so on. These field strengths are subject to natural variation from place to place and from time to time and are, with little exception as yet, not controlled by man.

The man-made sources of loading are (1) those forces introduced into the structure by the processes of manufacture and erection that are not necessarily present in test specimens and that remain on completion of the building (e.g. rolling stresses, welding shrinkage restraints, pre-stress of various kinds and the results of force-fit in indeterminate structures), and (2) the steady forces, vibrations and shock due to the operation of machinery (machines, lifts, cranes, vehicles) and the movements of people and items of equipment arising from the occupancy, or transmitted from neighbouring sources of a similar nature. These man-made forces may also depend on the characteristics of the building and its contents but their magnitudes are to a considerable degree controlled by suitable care in manufacture, erection, or operation, and from the safety-factor point of view may merit somewhat different treatment from that accorded to geophysical loadings, which are often inescapable.

All loadings, from whatever source, are variable with time, due either to variations of 'field strength', variations in the structure or its contents, creep and stress-relaxation in materials or the inherent nature of the loading. Because of the problems of creep and of the simultaneous action of various kinds of load, the codes of some countries recognise the existance of loads of various durations and an ISO draft recommendation for standardisation of the definitions in this field is in existence.

GRAVITATIONAL LOADING

The 'field strength' of gravity varies very little, the maximum variation between pole and equator being of the order of 0.5 per cent, and the effects of height, of time, and of local anomalies being very small. The principal cause of variations in gravity loading, therefore, is in the mass, either of the structure or of the contents, and because of the relative constancy of gravity, variation in mass may conveniently be expressed as variation in weight.

STRUCTURE LOAD

Generally speaking, in the past the weight of the structure itself has been considered to be known to the designer and relatively constant in comparison with the imposed loads. In reality variations in the self-weight of the structure may occur in various ways, such as: (1) by changes in the moisture content of the materials due to drying out, rain, condensation, and flooding and possibly by chemical changes, (2) by structural alterations such as adding further storeys or replacing parts of the original structure, such changes being normally under the control of a designer, (3) by changes in floor, wall and ceiling surfacings and by the use of temporary partitions to sub-divide rooms, such changes being associated with particular occupancies and possibly best considered as part of the occupancy load. In addition there are sources of variation that do not affect the weight of the actual building, but which need to be taken into account as inaccuracies in the design process: they are (4) departure of the unit weights of building materials from those assumed by the designer and arising from variations in conditions of manufacture, (5) differences between the dimensions used in designing and those actually present in the completed structure.

Items (1) and (4) are presumably taken into account when standards for unit weights are drawn up and it would be interesting to know something of the variations found. Partition loads (Item 3) are included in a survey of loads on office floors being conducted by the reviewer. Item 5 has been the subject of research by Johnson (2) on 142 sites in Sweden. The thicknesses of reinforced concrete floor slabs were measured and compared with the values shown on the drawings, the differences being analysed statistically. The figures for 12 sites in one city are given in such detail that it is possible to ascertain that, for instance, 2.3 per cent of slabs were more than 16.3 per cent thicker than intended.

OCCUPANCY LOAD

Because buildings are usually for a particular kind of usage it is traditional to base recommended floor loadings on the type of occupancy e.g.

- Domestic (Houses, Flats)
- Institutional (Hospitals, Prisons)
- Educational (Schools, Colleges)
- Public Assembly (Halls, Auditoria, Restaurants)
- Offices (including Banks)
- Retail (Shops, Department Stores, Supermarkets)
- Storage (Warehouses, Libraries)
- Industrial (Workshops, Factories)
- Garages (including Car Parks).

Domestic Occupancy. Statistical information about the loads in 139 flats was obtained in 1953 in Sweden (2). This was incidental to other work and the published information is difficult to analyse because loading from persons and loading from furniture were not surveyed simultaneously. The loading (load/room area) from furniture in living rooms and bedrooms had a 99 per cent probability of not exceeding 515 and 605 N/m^2 respectively, but the room areas varied from 7.1 to 27.6 m^2. The loading from persons (assumed to be on areas of 30 m^2) had a 99 per cent probability of not exceeding 735 N/m^2.

Karman reports (3) an extremely useful investigation of floor loadings in 88 houses and 95 flats in Hungary. The intensity (load/area of room) of long-term loading from furniture and persons in halls, kitchens and living rooms was determined, and histograms of the loading levels are given. The possible re-arrangement of families between the dwellings (here taken as once every $2\frac{1}{2}$ years) is then allowed for statistically, giving revised probabilities for the given levels of loading. The mean long-term loading on areas of 10 m^2 is 980 N/m^2 and the load-increase factor to give a 99.86 per cent level of probability is 1.55. The effects of size of room and size of dwelling are also examined and given in terms of the mean loads on the given areas, the number of dwellings surveyed presumably being insufficient to determine the upper quantiles . Karman proposes as a conservative enveloping curve for areas up to 200 m^2 the relationship: mean load intensity for long-term loads = 980 (1 - area/400) N/m^2. The short term loads are also considered, perhaps less rigorously.

Institutional occupancy. Of the institutional occupancies, hospitals are clearly the most important at the present time. Apart from a survey of wards in three hospitals in New York State in 1924, not on a statistical basis (4), no factual information appears to be published. In any case current attention to space planning, to provision of greater privacy and sound proofness of wards, to centralisation of services, and to air conditioning is likely to produce a completely different pattern of loading from that which has existed in the past. This is an occupancy which ought to receive attention as modern hospital buildings become available for survey.

Educational occupancy. The principal sub-types of educational occupancy are schools, colleges for further education (agriculture, art, commerce, crafts and technology) and universities. There may be similarities between the occupancies of some parts of the buildings used for these various purposes and this may reduce the total number of variables in this category. Some parts of educational establishments may be considered (4) to be assembly occupancy, with the attendant problems of loading from persons; complicating factors are the use of schools for evening activities involving adults and the flexibility that is required for building housing colleges of further education. Some surveys in technical colleges are already in hand in Britain.

Public assembly occupancy. Public assembly covers a number of slightly different occupancies, some of which (e.g. churches, theatres, cinemas, planetaria and concert halls) have fixed seating and a maximum load from persons which is likely to be fairly consistent and uniformly spread but with considerable crowding in aisles and other circulation spaces. The other group includes restaurants, dance halls and other halls with moveable seating, all of which may be adapted to various purposes and in which crowding of persons and oscillatory dynamic forces are likely to occur. Sports stands would probably be considered as in the second group.

Some extreme values of loading were obtained in the USA (4) but no statistical information seems to be available. Assembly occupancies are probably relatively easy to survey but special attention should be paid to the variation of load with area considered and to the need for a proper sampling of the weights of persons. In addition, as with domestic and educational occupancy, deformation and dynamic effects may prove to be important characteristics, and in this connection some measurements made at the Building Research Station of the vertical forces exerted by persons rising from their seats may prove useful.

Office occupancy. Some rather general information on office occupancies was obtained in the USA in the early years of this century (4) (5). Apart from this, two surveys of floor loadings in offices are reported in the literature.

The first, by C. M. White (6) in 1930 for the Steel Structures Research Committee, was on 8 such tenancies in Britain totalling 15,000 m^2. The maximum load occurring on each of certain sizes of floor zone was given for each tenancy as a maximum load intensity. Examination of these showed that, if safes were excluded (to be dealt with separately as concentrated loads) there was for each tenancy a consistent decrease in the maximum load intensity as the area was increased. Unfortunately the published results do not include the frequency distribution of the load intensities within any one of the tenancies.

The other survey (5) was by Dunham in 1945 or thereabouts and was in two buildings in Washington D.C. of 42,000 m^2 total area. Here again frequency distributions of the loading intensity on specific sizes of floor zone are not given but only the maxima observed (with undefined probability) on certain such sizes on each floor. These maximum values show in general a decrease with area, a ten to one range on different floors of the same building and no great difference between the absolute maxima observed in the two buildings.

In Britain, The Building Research Station, in conjunction with the Construction Industry Research and Information Association, has made a survey of floor loadings on 200,000 m^2 of office accommodation involving 32 buildings and 119 occupying firms, and is currently analysing the results, using the process given in Reference (10).

Retail occupancy. Dunham reports (4) some sampling surveys of parts of two department stores in the USA which were carried out just before 1950. In both cases the sample areas on which the loads were assessed were fairly large (usually larger than bay sizes and forming part, or the whole, of departments), but the actual areas varied from sample to sample and parts of the buildings were ignored. On the basis of certain assumptions regarding the crowding of aisles the results showed that in each of the departments this latter condition was likely to be the ruling loading by quite a large margin, but no evidence was given of the incidence of actual crowding and its fall-off with increasing footage. From the loads present in the normal (uncrowded) condition it is possible by grouping departments of roughly similar areas to obtain some idea of the range (if not the frequency distribution) of load intensities on such areas within each building and to show how the buildings compare with each other in respect of the mean loads and the way in which this changes with increasing area.

A survey of the retail occupancy is at present being made by the Building Research Station in conjunction with the Construction Industry Research and Information Association.

Storage occupancy. Dunham gives (4) the results of a survey of two warehouses in New York and in Washington respectively. In the first-mentioned case the results are given in terms of the load intensities on structural bays, which were mostly about 40 m^2 but they are given in such a manner, that, together with the structural plan provided of a typical floor, it is possible to derive useful information about the load intensities on areas of bay size, and multiples thereof, in this one building. In the second survey the results are not given in sufficient detail for this to be done.

Industrial occupancy. Dunham (4) gives some figures for floor loadings obtained in surveys of a number of different factories in the USA. Here again floor zones of various sizes are involved and without further details the results are of limited use.

Bat' and Koshutin (7) have made a statistical investigation of the loadings in columns due to the use of gantry cranes in heavy duty ferrous metal shops and in assembly shops.

An appreciation of the problem of loading in factories is given by Apcar. (8). In view of the extremely wide variations in possible loadings, and the difficulties in specifying the types of industrial occupancy for which a building designed for particular loadings might be suitable, it is not clear whether it would be worthwhile to devote resources to survey and standardisation of industrial occupancy in the foreseeable future. Small workshops for carrying on a specific craft or trade and occupying part of a building surveyed as another occupancy would, of course, be an exception. However CIB (9) through ISO is attempting to at least standardise methods of assessment of industrial loadings.

Garages. The multi-storey car park or garage is now a common feature of towns. Fortunately there are limitations on the types of vehicle required to be accommodated, and given certain basic information, it would be relatively simple to carry out a statistical survey without disturbing users and without weighing on site. Any loadings recommended as a result of such a survey would not, of course apply to garage forecourts accessible to road traffic in general.

Some further subdivision of the above occupancy types might prove possible, but within a given type the demands of interchangeability may make it pointless to specify loadings for the different uses of individual rooms.

However, in some occupancies there may be particularly heavy indivisible loads that merit special supporting arrangements, and therefore fixed positions. These are really within a separate category of 'loads known to the designer' but it may not be impossible to ask that some of the normal heavier kinds of load in certain occupancies should (even if divisible) occupy restricted positions e.g. in basements or in bays adjacent to spine walls, where their presence can be designed for.

Incidentally, if codes gave an indication of the ruling loads that were taken into account in drawing up the recommended loadings it would be extremely useful - to designers because they could assess whether any 'known loads' are abnormal, to code committees when reviewing regulations, and to those responsible for enforcing, and therefore interpreting, the regulations.

It should perhaps be noted here that all occupancies for which surveys have so far been made show a decrease in the load with increase in the size of floor zone considered and it would seem desirable that recommended loadings should be expressed either directly, or by implication, in terms of the area of the floor zone considered, possibly in the form 'X New tons per A square metres'. This point needs emphasis because, whilst in the past it may have been adequate to assume an average bay size when recommending imposed loads for floors, with some reductions for beams and columns, the surveys which have so far been made show a fairly rapid decrease in loading with increase in area at the sizes of bay formerly used and there is the possibility that for some of the larger bays that are now possible with modern constructional systems the recommended loadings might be unnecessarily heavy and therefore restrict development. On the other hand, the use of pre-fabricated floor units, and the problem of possible load concentration on other structurally significant areas smaller than normal bay size, mean that load specification independent of area may result in lowered safety factors.

EQUIVALENT UNIFORMLY DISTRIBUTED LOAD (EUDL)

It is usually assumed that the loads actually imposed on a building are independent of the type of construction used. In the case of gravity loads this is only true to the extent that the deflections, vibration characteristics and load-distributing abilities of particular systems do not affect the practices of occupiers. However where such effects exist they may be considered to be restrictions on the user and ideally he should not need to take account of the type of construction when making use of the building.

Although the applied loads may be independent of the type of construction, the EUDL cannot be specified without taking the latter into account. It is only the presence of high structure loads that smooths out the irregularities due to the concentration of occupancy loads, and even then errors of 10 per cent or more can occur. Any lightening of structure load due to lighter cladding and partitioning, to the use of new materials of lower density, to higher permissible stresses, to reduced factors or safety, or to reduced imposed loadings would make this situation more unfavourable. In addition, novel systems of construction that are more sensitive to load concentration might be developed and reference would have to be made to the structural actions involved before deciding on the validity of the EUDL method.

Since it is convenient to have only one system of codified loadings, the pecularities of individual systems, as regards their ratios of imposed loads to structure loads and their structural actions, could best be taken care of by special factors for each such system. An alternative approach, which might succeed in divorcing the specified loading from the type of construction, would be to specify actual observed loads and their dispositions. Even if this could be done in a simplified form it is doubtful whether this approach would be acceptable for Code and general design purposes, though it might well form an Appendix for guidance when considering advanced designs, giving, for instance, the most irregular dispositions and their frequencies. Such information would in any case be needed by Code Committee when choosing the load concentration factors for novel methods of construction.

Yet a third possibility would be to specify a uniformly distributed load together with a concentrated load of given magnitude, which the designer could place at the worst position for his particular design.

Ideally, any such concentrated load ought to be based on survey observations and not be a purely notional load. Doubtless, however, most designers would prefer to use an EUDL together with a factor for the type of construction.

The reviewer has given (10) a computer-aided method of analysing the results of floor loading surveys. The major floor zones in each building are notionally subdivided into floor slabs of successively varying size and shape and histograms are prepared showing the frequencies of occurrence of various levels of load on each bay size in turn. The EUDL's for the most heavily loaded bays are then computed for various slab boundary conditions and in terms of various parameters, such as central deflection, central bending moments, and so on.

VARIATIONS WITH TIME

In the case of gravitational loadings due to imposed immobile loads in a particular type of occupancy, there is variation not only from zone to zone but also from time to time. The time-variability may be considered to consist of a short-term variation such as might be caused by re-arrangement of existing loads that are typical of the occupancy, and a long term variation such as might be caused by changes in the general character of the loads normally found in that occupancy.

The random variations in loading which might occur on particular floor zones as a result of short-term variations will probably not affect the frequency-distribution of loadings, since the resulting modified loadings will almost certainly have been found already on other zones (in the same or another building). In this case variation with time can be assumed to be the same as variation with location, and Karman has shown (3) that on this basis an application of probability theory leads to a simple formula for assessing the revised probabilities. (In short, if a load occurs with probability p in any one population of loaded floor slabs, it will occur with probability p^n after n re-arrangements).

The long-term trends cannot be treated in this way and inevitably there will be a need for new surveys of certain occupancies from time to time. These will be made increasingly easily as expertise grows.

Turning now to the mobile gravitational loads such as are produced by people and by mobile equipment, there is a fairly frequent or short-term variation with time which, as before, may be considered to be adequately covered by observed spatial variations. There is however in certain occupancies a medium-term variation due to increased stocks of goods or to crowding of people at certain times of year or on certain occasions (e.g. Christmas, sales times, visits by 'personalities', fire), which may be of over-riding importance. Finally there are long-term and regional variations in the average weight of people.

METEOROLOGICAL LOADING

By meteorological loading is meant the loads which arise because of atmospheric conditions outside and inside the building. These include loads from winds (both steady and gusty), snow and ice, rain and hailstones, dust, and the effects of restraint of the thermal and moisture movements of the materials used in construction. Thermal and moisture movements and wind loadings depend on internal atmospheric conditions as well as on those outside but conditions inside the building are so closely controlled by man, or by conditions outside, that only variations in the external atmosphere need to be considered. Hence it can be said that all meteorological loads depend on the field strength of certain phenomena in the external atmosphere. They also depend on the type, size, shape and location of the building and are, with minor exceptions, independent of the occupancy. There is usually a variation in intensity with the size of the area being considered.

The field strength of meteorological loadings is inherently variable with time as well as with the locality being considered. For each such locality the usual pattern consists of a series of fairly regular cyclical variations, together with less regular variations to do with immediate, local, regional and world meteorological conditions. Such chronological variations of meteorological loading may in principle be looked upon as a fixed background against which the building life is moved, so that the statistical population is defined by the position of the 'building-existence' in the time scale and the variate consists of the highest load (of the given duration and on the given area etc.) occurring within the intervals so defined. Here it becomes necessary to make assumptions about the length of the 'building existence' and about the times when buildings are erected; for example, one might assume a life of 60 years for domestic buildings, with equal numbers to be built each year, so that the variate would be defined as 'the highest load of a given duration and on a given area etc., occurring in a population of intervals of 60 years overlapping by one year'. Clearly if more information is available about the rate of completion of buildings the samples can be appropriately weighted. Whether enough information is yet available to determine the meteorological background is another matter and probability methods may also enter into the solution of this, quite separate, problem.

On the basis of a variate defined as above, it is common practice to use Gumbel's extreme value theory to predict the maximum level of loading that will occur within a given 'average return period' equal to the assumed life of the building. The method has theoretical limitations - it assumes that there is no limit, for instance, to the amount of snow that can fall, and that each maximum fall is independent of any other, thus ignoring any possible trends - but its validity in practice can be progressively tested as observations are extended into what is now the future.

SNOW LOADING

Because of climatic variations between and within countries there is little point in direct comparison of snow loadings given in national codes and it is more important to study the known phenomena of snow distribution on roofs, with a view to the making of national or regional surveys from which the loads can adequately be predicted. A preliminary report, which has since been generalised, was prepared by Schriever and Otstavnov (11) for CIB Committee W 23.

This is a very useful summary of the effects to be observed and the methods by which the resulting snow loads are taken into account in the codes of Canada and of the USSR - two countries which have a wide range of climates and a particular interest in, and experience of, snow on roofs.

The snow load on a roof depends on the product of the natural 'field strength' (here called the 'climatological ground snow load') and factors to do with the type, size, proportions, site and orientation of the building and the heat loss through its roof.

Snow on the ground. In any given major climatic area (of which there may be several in a very large country) the heaviest snow loads on the ground vary according to the region, the district, and the locality or site. The regional variations and some of the district variations (e.g. those due to altitude, proximity to the sea, or the existance of a large conurbation) may be considerable and it may prove desirable to specify the resulting snow loads separately. Clearly there is need to limit the number of such zones used in codes, and very local variations would be therefore ignored except for their contribution to the regional average. When determining the latter, the safety/economy basis for assessing snow loads implies that observations of ground snow load within a code region ought to be statistically weighted according to the number of new buildings expected, particularly those of low-rise or wide span, in the part of the region where the observations were made. The existing population level may often be a sufficient index of this.

Conditions of greatest snow load may occur as a result of a single heavy fall of snow, or of accumulation of several falls of snow, or of snow followed by rain. At a given location, observations of snow depth and density, or of the equivalent depth of water, are made over a period of years and the maximum value for each year determined. This period may be fairly limited, but in view of the need to attempt nevertheless to estimate the maximum load for a longer period approximating to the life of a building, a statistical analysis using an extreme value distribution is sometimes used. This yields the expected maximum snow load on the ground in a specified 'average return period'.

Snow on roofs. Except in windless or very sheltered conditions the total load on a roof tends to be less than that on the same area of ground, because during the fall some snow is removed by wind. The wind may also remove parts of individual deposits later, and there may be evaporation and melting due to diurnal rise in air temperature or to heat loss through the roof; on the other hand melting, followed by nocturnal fall of temperature and consequent re-freezing may tend to prevent removal by winds. Relatively little loss occurs due to insolation.

Drifting, melting, and the receipt of snow blowing from, or sliding from, higher roofs affect not only the total load on the roof but also its distribution so that in places, notably those where the shape of the roof produces a local decrease in wind speed, the intensity of snow load on the roof may be greater than that on the ground. The ratio of roof load to load on the ground is sensitive to wind speed and direction and particularly so to its duration, and it appears unlikely at present that the resulting variations from building to building will be calculable specifically, though Otstavnov and Rosenberg do give (12) a method for use in the case of flat roofs.

A more generally applicable statistical approach is therefore called for, in which the loads on a large number of buildings of a given type are observed and related to the regional average snow load on the ground. In a survey recently begun in Britain, for instance, about 350 buildings are under observation by volunteer observers, and a survey of this nature has been under weigh for many years in Canada. In the latter country there is indeed an attempt (13) to give designers additional information about the effects of particular features of a building.

COMBINATIONS OF LOADINGS

If a structure is subject to the effects of two sources of load acting simultaneously and the presence of one loading does not influence the magnitude of the other loading, the structure may be considered to be one of a population of such structures in which the one oading occurs with the same spatial probability at all levels of the other loading, and *vice versa*.

In these circumstances the probability p of the combined loading is less than that p_a, p_b of either of the other two loadings separately, (since $p = p_a \times p_b$) and if the safety margin is not to be increased there is the possibility of reducing the separate design loadings when combinations of these are present. Of course, each loading combination is a separate design problem and the choice of the relative levels, of the two loadings in the combination, to be used by the designer will be influenced by the behaviour of the structure as well as by statistical properties of the loadings.

In most cases of combinations of spatially variable gravity loading with spatially variable wind or snow loading the joint probabilities may be obtained, as above, by multiplication of the separate probabilities. However, if the methods of specifying wind or snow loadings assume that no spatial variation exists, the appropriate spatial probability p_b, say, is unity, and no reduction in the design wind load or snow load when in combination with gravity loads is then to be envisaged, unless there is a chronological variation in the gravity load.

In the case of combinations of two or more time-variable loads such as wind and snow the durations of the individual loads of different categories may, in some climates, not overlap and if, for instance, we take the product of two separate spatial probabilities of given values of snow and wind loads, we merely obtain the percentage of buildings on which both values of load will occur at some time or another, but not necessarily simultaneously. Of course, in some climates, the duration of snow load may be so protracted that multiplication of spatial probabilities is justified but even this will only be valid if there is no interaction between the two categories of loading.

For reasons, therefore, to do with non-overlapping and possible interaction of loadings it is preferable to determine time-variable loads on the basis of statistical information about one loading obtained during the presence of each of a set of given levels of the other loading, including zero.

Of course, the degree to which any of these effects are significant can only be ascertained when the necessary data has been collected and applied to typical structures, and in any case much simplification would be desirable for purposes of codifying.

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SUMMARY

A brief review giving a classification of loadings on structures and an overall view, from the point of view of modern statistically orientated design procedures, of the information already available, and that still required, in relation to structure loads (dead loads), occupancy loads, snow loads, and combinations of loadings.

RESUME

Cette communication donne une classification des charges sur les bâtiments. En ce qui concernce les méthodes de calcul modernes orientées vers la statistique, elle présente un aperçu des informations dont on dispose déjà et de celles dont on a encore besoin au sujet des charges statiques, des surcharges de service, de la neige et des charges combinées.

ZUSAMMENFASSUNG

In diesem Bericht werden die Lasten auf Bauwerke in Gruppen geordnet. Der Verfasser gibt vom Standpunkt der modernen statistischen Konstruktionsverfahren aus einen Ueberblick über die schon zur Verfügung stehenden und die noch zu erfassenden Auskünfte über Belastung durch Eigengewicht (ruhende Last), Nutzlast, Schneelasten und Lastkombinationen.