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Brass, A. E.

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By Allen E. Brass,

National Research Council of Canada

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Methods of Measuring the Area and Volume of Buildings

By Allen E. Brass, National Research Council of Canada

Abstract: The importance of establishing a uniform method of measuring area and volume of buildings for the purpose of cost comparisons is recognized by building scientists and building owners throughout the world. This paper reviews the material on this subject available in the library of the Division of Building Research (Canada), and reports on an international survey involving 34 organizations in 24 countries. Similarities and differences among methods of measurement currently in use are summarized in tabular form.

CALCULATIONS OF THE SIZE of buildings may be made for a variety of purposes. Perhaps the most common of these is to establish the cost of construction in terms of cost-per-unit area, or volume. It is important that calculations of the size of different buildings be made in a similar manner, so that comparisons will be valid, and so that the resultant figures for different cases will be consistent. This suggests that there is a need for the establishment of a standard method for the calculation of building sizes.

Such a need has been recognized by different groups associated with the construction industry, and some work has already been done toward standardization. In the United States, England and Australia, for example, there are standards or recommendations prepared by organizations such as the American Standards Association, American Institute of Architects, the Royal Institute of British Architects, and the Royal Australian Institute of Architects. Similar standards have been prepared by comparable organizations in Finland, Norway and Sweden. Recently, the Division of Building Research of the National Research Council of Canada undertook a study of this matter at the request of the Research Committee of the Royal Architectural Institute of Canada.

Even a cursory examination of the literature on the subject indicates a wide variation in the procedures used for determining building size in countries around the world, as well as a resulting general lack of uniformity in terminology and methods of measurement. It was decided, therefore, to undertake a comprehensive

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BRASS, ALLEN E. Building Standards Section, Division of Building Research, National Research Council of Canada; currently enrolled in the Division of Town and Regional Planning at the University of Toronto.

study of existing methods as a first step toward the possible development of suitable standards of measurement.

This study has been completed, and it is being reviewed by a Committee of the Royal Architectural Institute of Canada. In the meantime, the importance of establishing a uniform method of measuring area and volume of buildings for the purpose of cost comparisons was recognized by the Building Research Institute Committee on Methods of Building Cost Analysis. This paper deals with that subject. It is based upon a review of material available in the library of the Division of Building Research, as well as on an international survey involving inquiries to 34 organizations in 24 countries. It is interesting to note that replies from Denmark, France, Japan, and New Zealand indicate that the cubic content of a building is a measurement rarely used in those countries.

The survey was concerned in very broad terms with methods of measuring the size of buildings, and was not confined to the methods used in calculating area and volume for cost analyses. This paper is, therefore, an extract from that more general work. The aim of this report is not to propose a specific standard for adoption, but to summarize the similarities and differences among various methods of measurement currently in use. It is hoped that this comparison will stimulate discussion and encourage a further exchange of ideas on the subject, and that in this way it will assist in the further development, and perhaps the eventual broad adoption, of suitable standards for determining the area and volume of buildings for the purpose of cost comparison.

METHODS OF MEASURING AREA

The various methods of measuring the area of buildings are applicable to buildings of all types. They refer to over 24 items for which 18 terms are used. An analysis of these items according to the detailed definition and method of taking dimensions reveals that they can be grouped into six general categories: gross area, net area, occupancy area, usable area, circulation area, and service area. The methods of measurement which fall into the first category, referred to as "gross area," are those intended primarily for use in cost comparisons.

In gross area measurement are included all those methods that encompass the area contained within the outer faces of exterior walls, or the center line of party walls between buildings. Fourteen methods of measurement fall into this category and some of the terms used include the following: total story area, gross area, architectural area, building area, and story area. Table 1 lists the items mentioned in the various methods of measuring gross area, other than in the major usable portions of a building. The items shown as "Included" are those that were specifically mentioned as being included in more than half of the methods of measurement,

or which would presumably be included by the definition and method of taking dimensions. The same is true of items in the "Excluded" column. In the "In Doubt" column are those items that are included in some methods and excluded in others, but which are not mentioned as either being included or excluded in more than half of the cases.

TABLE 1 -- ITEMS MENTIONED IN METHODS OF MEASURING GROSS AREA OF A BUILDING OTHER THAN ITS USABLE PORTIONS

Items Included in Majority of Cases	Items Excluded in Majority of Cases	Items in Doubt
Interior partitions	Exterior paved areas	Porches
Stairways	Exterior steps	Balconies and balcony corridors
Elevator shafts	Pipe trenches	Penthouses
Duct spaces	Crawl spaces	Attached and built-in garages
Projecting stories	Roof overhangs and canopies	Unfinished portions of basements and attics
Mezzanines	Carports	Unenclosed portions of a story under another story
Halls	Interior light shafts	Unenclosed roofed-over paved area
Vestibules		
Closets		
Fireplaces		
Bay Windows		
Dormers		
Garrets		
Chimneys		
Utility rooms		
Finished rooms in basements and attics and stairs and halls leading to them		

METHODS OF MEASURING VOLUME

The majority of methods of measuring the volume of a building are applicable to all building types; the remainder apply primarily to housing. The various items fall into two categories which, for purposes of this study can be referred to as gross volume and net volume. The gross volume figure is the one that would be used as the basis for cost comparisons. Some of the terms used in referring to this item are: building cube, cubic contents, cubical extent, total volume, architectural volume, and building volume.

With respect to the calculation of gross volume, without exception the plan dimensions are taken to the outer faces of exterior walls or to the center line of walls separating buildings. There is

considerable variation, however, in the methods outlined for the measurement of height to be used in calculating gross volume.

The various low points for taking the height are:

1. Bottom of concrete foundations
2. Average depth of footings
3. Plans of the foundation which may be:
   a. Level of bottom of the foundation trenches or under side of the slab, or
   b. Half the depth of piers or piles below the under side of beams carried on them, or
   c. For existing buildings, 2 ft. below lowest floor level for buildings up to three stories, and 5 ft. for buildings four or more stories, or
   d. Mean depth for irregular foundations
4. Top of the concrete foundation
5. A plane 6 inches below the lowest floor
6. A plane 20 cm below basement floor level where it is on ground
7. The under side of the lowest floor
8. One foot below the top surface of the lowest floor or one foot below the average ground level around the enclosing walls, whichever is lower
9. The upper surface of the lowest floor level
10. Grade level (for porches only).

The most common low point for taking height dimensions is 9 (the upper surface of the lowest floor level). It is indicated in seven of the 14 methods for measuring volume. The next most common is 7 (the under side of the lowest floor level) indicated in five of the 14.

The high point to which the height dimension is taken also varies considerably and is specified in various ways as follows:

1. Half the height of a pitched roof from the intersection of the walls and the roof to the ridge
2. Half the height of a pitched roof between the level of the eaves and the ridge.
3. The level of the eaves of a pitched roof
4. A plane 2 ft. above a flat roof
5. The exterior surface of the roof

6. The interior surface of the roof construction
7. The upper surface of the upper ceiling construction
8. The top of the ridge, or peak of an attic roof.

Of these, the most common is 5 (the exterior surface of the roof), which is indicated in nine of the 14 methods. The next most frequently used are 1 and 2, which are referred to three and four times respectively.

Table 2 lists the total number of different items mentioned in the 14 different methods of measuring volume in addition to the major usable portion of a building. It was compiled in a manner similar to that used for Table 1.

TABLE 2 -- ITEMS MENTIONED IN METHODS OF MEASURING GROSS VOLUME OF A BUILDING OTHER THAN ITS USABLE PORTIONS

Items Included in Majority of Cases	Items Excluded in Majority of Cases	Items in Doubt
Porches	Terraces	Verandas
Bay windows	Exterior steps	Balconies
Oriels	Exterior garden walls	Fleches
Turrents	Breezeways and paved roofed-over areas	Lanternlights and skylights
Domes	Light wells and areaways	Foundation and construction below lowest floor level
Dormers	Canopies, cornices, roof overhangs	Interior courts
Chimney stacks	Parapet walls	Attached buildings
Attics and roof spaces	Gateways	Penthouses
Interior staircases	Sheds and covered yard spaces	Crawl spaces
Cellars and mechanical rooms below basement floor level	Covered walks	Garages
Basements		Towers
Mezzanines		

CONCLUSION

In general, the various methods of measurement are concerned with four categories of space. These are:

1. The major usable portions of the building
2. Plan projections such as porches, carports, bay windows, and balconies
3. Roof spaces such as attics, penthouses, machinery rooms and other spaces above the roof

4. Foundation spaces such as basements, crawl space, pipe trenches, unexcavated spaces, and special foundations.

The greatest difficulty arises from the arbitrary way in which the last three categories of spaces are handled. With respect to these, some of the methods in use have extensive lists of the items to be included and excluded and are, therefore, very comprehensive in their scope. Others list only a few items and leave many open to question.

In several of the methods, these additional spaces are considered in part, and their size is multiplied by an appropriate factor. For example, some methods indicate that only half the area or volume of an enclosed porch is to be included in the calculations. In others, the spaces are included only where the height exceeds a certain minimum, and excludes where it is less. For example, some methods provide that all spaces 6 ft. 6 in. or higher are to be included in area and volume calculations regardless of use, while in others attic spaces higher than 1.5 m or 5 ft. are included and those lower are excluded from the calculations. In most methods, however, all of the spaces included in the calculations are measured in full.

The two standards for the measurement of area and volume of buildings prepared by the Finnish Architect Association Standardization Institute deserve special mention, because they are among the most comprehensive and detailed standards reviewed in the study. They are virtually glossaries of methods for making various measurements of the size of buildings. The one on area, for example, includes methods of measuring the area of a room, of a dwelling unit, of one story, of a building, and of the projected plan area. In each case, information is included on the method of taking dimensions as well as the items to be included and excluded, and there are illustrations to amplify the text. Each of these standards carries an explanation of the number of significant figures and the degree of accuracy to be used in the calculations, as well as an example worked out to show how to calculate and express the results. In the standard on the measurement of area, there is also a list of definitions of terms such as story, attic and mezzanine, to further clarify the description of the items listed.

It is apparent that an outline of the method of measuring building size should specify the method of taking dimensions and the items to be included as well as excluded, and should be presented in sufficient detail so as to be applicable to the wide variation in configuration of building plans and sections. The study has revealed considerable information from which standards for measuring the area and volume of buildings can be developed for use in cost analyses. It is hoped that this paper will be a contri-

bution toward that objective. The study of the measurement of buildings is continuing within the Division of Building Research and, on an international scale, it is expected that the Conseil International du Batiment will be developing it still further in the near future.

OPEN FORUM DISCUSSION

Unsigned question: Mr. Brass' talk dealt with the results of a survey made by the National Research Council of Canada. Will there be a set of recommended standard methods forthcoming? Do you think that recommended standard methods would be widely adopted by all groups interested in buildings?

Mr. Brass: Let me clarify what the position of the Research Council was in carrying out this study. We have regular meetings with the Research Committee of the Royal Architectural Institute of Canada. At a recent meeting we discovered that the Division of Building Research and the RAIC were very interested in this question of a standard method of determining the area and volume of buildings for realistic cost comparisons. The Division agreed to undertake the study in view of our international association with the building research organizations around the world. We have prepared this paper. Our policy is that it is now up to representatives of the various facets of the building industry to get together, review this information, and reach some agreement on a standard for its use. An interesting development of this is that if you examine these recommendations, you find that although they differ, the differences are really quite minor and all the standards are, in effect, quite arbitrary. Therefore, with very little compromise on an international basis, it should be possible to develop one standard method of measuring the area and one of measuring volume for cost purposes. Mr. Legget, the Director of the Division of Building Research, is a member of the Executive Committee of the International Council for Building Research Studies and Documentations. That organization is going to investigate the possibility of promoting the development of an international standard. With regard to the anticipated adoption of a standard, I can't really see why there should be any strong resistance to it. The important thing is that everybody recognizes that this is a tool for our use and, until we have this tool, we are just complicating the problem of making cost comparisons between one building and the next.