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**MBMA'S NEW LOW-RISE BUILDING SYSTEMS MANUAL**

by

Dale C. Perry<sup>1</sup> and Joe N. Nunnery<sup>2</sup>

**INTRODUCTION**

Traditionally, much of the information found in engineering literature relative to the design and construction of buildings, focuses for the most part, on the more glamorous area of high-rise construction. This occurs in spite of the fact that the overwhelming percentage of non-residential construction is comprised of buildings of three or less stories in height. Adding to the void in published information is the emergence over the past two decades of the building systems approach as the preferred method for all types of low-rise construction.

In 1982, the Metal Building Manufacturers Association (MBMA) appointed a special subcommittee of leading engineers and researchers within the metal building industry to develop a new manual devoted to the building systems approach to metal structures. The charge given to this body was to:

1. conduct a thorough and systematic investigation of recent and ongoing research sponsored within the steel industry and allied construction organizations,
2. review current design and construction practices,
3. study present building code requirements relative to low-rise buildings and develop new provisions where appropriate, and finally
4. compile this information into a single document.

As work proceeded, it became apparent that much of the information being gathered, particularly in the areas of environmental loads and crane systems, was applicable to all forms of construction. Thus, it is suggested that the **LOW-RISE BUILDING SYSTEMS MANUAL**, which represents the culmination of four years of extensive work by the subcommittee, is a valuable resource document for engineers, architects, contractors, code officials and students pursuing technical programs of study at colleges and universities throughout the country.

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The MANUAL has been subdivided into seven sections:

- 1) DESIGN PRACTICES,
- 2) COMMENTARY,
- 3) COMMON INDUSTRY PRACTICES,
- 4) GUIDE SPECIFICATIONS,
- 5) BIBLIOGRAPHY,
- 6) NOMENCLATURE, and
- 7) APPENDIX

The contents of each are briefly described in the following portions of this communication. The MANUAL includes an updated version of, and replaces, the 1981 version of the MBMA "Metal Building Systems Manual"(1) and 1982 edition of the "Crane Manual for Metal Building Systems(2). In each case, the material contained in these documents has been extensively updated and expanded to apply to all types of low-rise building construction.

#### DESIGN PRACTICES COMMENTARY

##### General

The continued development of computer software has enabled engineers to analyze complex building systems under prescribed loading criteria and determine corresponding structural actions (internal forces, stresses, displacements, etc.) to a high degree of accuracy. What has often been overlooked, however, is that in such refined analyses, the magnitude of loads which a structure may be called upon to resist during its lifetime, can rarely be predicted within two significant figures. Quite typically, design textbooks and manuals provide only a "hand wave" at the loading problem. Indeed, the material in the design load chapter of such documents rarely changes from one edition to the next. In recognition of this fact, the metal building industry early on assumed a leadership roll in sponsoring research aimed at quantifying design loads for a large number of applications encountered in low-rise building design.

The first two sections of the manual reflect the end results of this effort and provide the most complete definition of environmental loads, crane loads, and floor live loads to be found anywhere in engineering literature. For convenience of the user, and in keeping with the typical format of U.S. standards and specifications documents, the loads are prescribed in the most concise form possible in the DESIGN PRACTICES SECTION. The following COMMENTARY provides discussion of the rationale on which the loads are based and references the supporting research and other pertinent documentation.

##### Roof Snow Loads

Perhaps the first rational procedures for assessing roof snow loads in the United States were introduced in the 1981 version of the MBMA manual. The current manual reflects the extensive research conducted since

that date and, in particular, includes detailed procedures for treating drifting and sliding snow. Sample snow load calculations for three (3) DESIGN EXAMPLES are presented to illustrate the applications of the provisions.

It is worthy of note that two of the three model building code authorities, ICBO: Uniform Building Code(3) and BOCA: Basic/National Building Code(4), have recently adopted snow load provisions based on the MBMA document. Similar provisions will be advanced for consideration by SBCCI: Standard Building Code(5) during the next code cycle.

### Wind Loads

Again, early on the metal building industry recognized that the old "projected area methods" for assessing wind loads should go the way of the dinosaur. Experience based on the performance of low buildings subjected to severe wind events and more recent wind tunnel experiments, suggested that building codes in use prior to 1981, in general, overestimated the magnitude of "main framing" loads while at the same time underestimated the high, localized loadings which may be induced over small tributary areas adjacent to the geometric discontinuities in the surfaces of the building. Beginning in 1976, a comprehensive research program was initiated at the Boundary Layer Wind Tunnel Laboratory of the University of Western Ontario under the joint sponsorship of MBMA, AISI and the Canadian SSBI; and, this work is still continuing at present. The wind tunnel experiments, which were tailored for specific applications in low-rise building design (in terms of gross building geometry and permeability, framing considerations, terrain exposure, etc.) presently provide the most comprehensive data base yet reported. The provisions found in the MANUAL reflect research completed through 1985 and have been adopted, in their entirety, by the Standard Building Code(5). Additionally, BOCA Research Report No. 83-18(6) and ICBO Evaluation Report No. 4018(7) permit the use of these provisions for low-rise metal building systems. The provisions are similar to those adopted in the latest and earlier editions of the National Building Code of Canada(8) for all low buildings.

Translation of state-of-the-art knowledge into the wind provisions contained in this document presented a formidable task. To assist the reader in developing an understanding of the various tradeoffs and compromises made in codifying wind effects, additional information is provided in the COMMENTARY and more detailed discussions on the fundamentals of wind engineering are contained in Sections A4-A6 of the APPENDIX. Recognizing the complexities associated with the wind load provisions contained in this document, sample calculations are presented for seven (7) DESIGN EXAMPLES covering a wide range of design applications.

### Crane Loads

Introduced in 1982 as a supplement to the 1981 MBMA Metal Building Systems Manual, the "Crane Manual for Metal Building Systems"(2) soon achieved the status of the most comprehensive, single source document for

the specification, design, fabrication and erection of crane buildings. The information contained therein was updated and expanded by the subcommittee to include the most current data available for the design of all types of crane buildings with bridge, monorail, jib and single-leg gantry cranes. The information contained in this section combines the metal building industry's years of field experience and research together with the provisions and other data contained in the appropriate ANSI and CMAA Specifications(9-15) and AISE Standard(16).

Again, in keeping with the format of the other sections on loading, the provisions on crane loads are concisely presented in a user-oriented manner. Additional supplementary information on crane systems and supports is provided in the COMMENTARY and Section All of the APPENDIX. It is worthy of note that the Basic/National Building Code(4) has approved, by reference, the provisions on Crane Loads set forth in this manual, for inclusion in the 1987 edition of the code. Similar provisions have been advanced by MBMA for consideration by the other model building code authorities(3,5) during the next code cycle.

### **Floor Live Loads**

With the extension of the building system approach to low-rise, multi-story applications, there emerged a need to review existing information and generate new data on floor live loads. The information contained in this section reflects a comprehensive study of the data found in other design manuals, building codes and the metal building industry's years of experience. The live load data covers a wide range of building applications including office structures, hospitals, schools, libraries, hotels, light and heavy manufacturing facilities, gymnasiums and related sports facilities, garages and storage warehouses.

### **COMMON INDUSTRY PRACTICES GUIDE SPECIFICATIONS**

The metal building industry traces its parentage to the World War II era when small, rigid-framed structures were marketed directly to the public via order catalogues. Today, the industry produces a large variety of low-rise buildings including structures to six stories in height, utilizing a true design/build concept. Design, drafting and fabrication are combined under one roof with the buildings erected by general contractors who normally receive training in both building sales and erection from the individual MBMA manufacturers. The result is an unusually reliable, completed building.

The section, COMMON INDUSTRY PRACTICES, replaces the Code of Standard Practices found in other industry manuals and describes traditional practices relative to the design, manufacture, sale and erection of metal building systems. A summary of each of these practices is given and the

normal responsibilities of the manufacturer, contractor(s), dealer, design professionals (architects, engineers) and owner defined.

GUIDE SPECIFICATIONS provides appropriate information to serve as a recommended guide in the preparation of performance specifications relative to the design, materials, fabrication, shipment and erection of metal building systems.

#### BIBLIOGRAPHY

The MANUAL provides a comprehensive bibliography containing over 200 references pertaining to environmental loads, crane loads and additional information relevant to the design of metal and other types of low-rise building systems.

#### APPENDIX

As noted previously in this communication, every attempt has been made to present the information contained in the earlier sections of the Manual in a very concise form for the benefit of the user. The object of the APPENDIX is to supplement the COMMENTARY, present more fully the rationale behind certain provisions, and offer additional state-of-the-art knowledge pertaining to other important aspects involved in the design and construction of low-rise buildings. The user may find particularly interesting the sections on ENERGY CONSERVATION, WIND LOADS, FIRE RATINGS, ANCHOR BOLTS AND FOUNDATIONS, CRANE SYSTEMS AND ROOF EXPANSION AND CONTRACTION.

The section, ADDRESSES OF ORGANIZATIONS, lists the acronym, full name, current mailing address and telephone number of a large number of technical organizations and should prove invaluable to the user. The APPENDIX concludes with two sections on climatological data and provides the practitioner with information gleaned from a variety of governmental and industry sources. A unique listing of wind speed (and distance inland for hurricane coastline), ground snow load, rainfall intensity and seismicity is provided by county for the contiguous United States. Heating and cooling degree days, minimum and maximum ambient air temperatures, and average monthly clearness index values are given for a large number of recording stations located in all 50 states.

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