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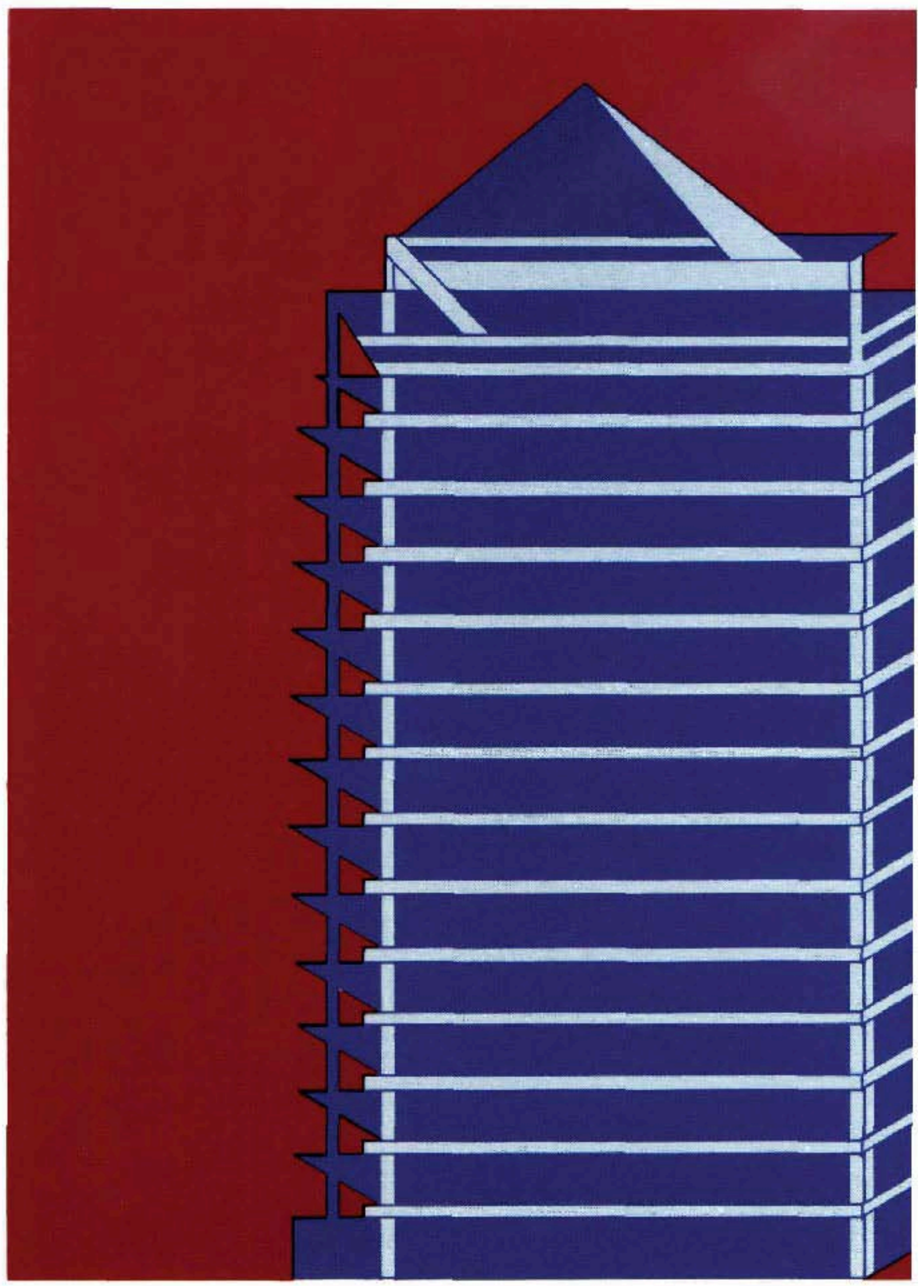
Steel Design Guide Series

Low-and Medium-Rise Steel Buildings



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Low- and Medium-Rise Steel Buildings

Design Guide for Low- and Medium-Rise Steel Buildings

Horatio Allison, PE
Consulting Engineer
Dagsboro, Delaware

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Printed in the United States of America

Second Printing: October 2003

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PREFACE

This booklet was prepared under the direction of the Committee on Research of the American Institute of Steel Construction, Inc. as part of a series of publications on special topics related to fabricated structural steel. Its purpose is to serve as a supplemental reference to the AISC Manual of Steel Construction to assist practicing engineers engaged in building design.

The design guidelines suggested by the author that are outside the scope of the AISC Specifications or Code do not represent an official position of the Institute and are not intended to exclude other design methods and procedures. It is recognized that the design of structures is within the scope of expertise of a competent licensed structural engineer, architect, or other licensed professional for the application of principles to a particular structure.

The sponsorship of this publication by the American Iron and Steel Institute is gratefully acknowledged.

DESIGN OF LOW- AND MEDIUM-RISE STEEL BUILDINGS

BASIC DESIGN RULES FOR ECONOMY

A few basic design rules for economy will be presented herein. These rules should be considered in the conceptual phase in the design of a project. There are, of course, many other considerations, but these suggestions are simple and can help in producing a good economical design.

The cost of a filler beam and/or girder beam simply consists of the cost of the mill material, the cost of fabrication, and the cost of erection. The cost of fabrication and erection for a single beam is essentially the same for a heavy beam or a light beam. The real savings for a light member compared to a heavier one is simply the difference in the cost of the mill material. Thus, beams should be spaced as far apart as practical to reduce the number of pieces which must be fabricated and erected.

Rigid moment connections and special connections for bracing are expensive. Care should be taken to minimize the number of these types of connections in a project—that is, reduce the number of moment resisting and braced bents to the minimum. Where practical, one may consider the use of only spandrel moment resisting frames to resist wind loads. Deeper, more efficient sections may be used thus minimizing the number of moment resisting connections required.

Where appropriate, high strength steel (F_y = 50 ksi) should be used in lieu of mild steel (F_y = 36 ksi) for both columns and beams. The reason is simple—the price to strength ratio is about 25% lower for the higher strength steel beams and 10% to 15% lower for columns depending upon their length. For example, a W21x44 (F_y = 36 ksi) simple filler beam is the equivalent of a W16x26 (F_y = 50 ksi) composite filler beam. The difference in the cost of the mill material to the fabricator is about $3.90 per linear foot. The cost of the studs in place at a cost of $1.50 each is about $1.30 per linear foot. The cost of cambering or shoring is considerably less than the $2.60 per foot difference. The floor vibration ratings for the two beams are comparable. The required critical damping using Murray's criterion (Murray, 1991) for the W21x44 and W16x26 spanning 30 '-0 " spaced 10 '-0" o.c. with 10 psf ambient live load is 4.00 and 3.46 respectively. The higher strength steel beam is less costly and functionally equivalent. It should be kept in mind that there are situations where the use of high strength steel is inappropriate. Small inconsequential filler beams, channels, angles, etc., should be of F_y = 36 ksi steel, as this material is readily available from a fabricator's stock or a steel supply warehouse. Members for which strength is not the controlling design consideration, obviously F_y = 36 ksi material should be used.

Repetitive use of members and/or the same shape size is an important factor in the design of an economical project. Repetitive use of members reduces the detailing, fabrication, and erection costs. As an example, in composite construction where beam spacing for non-typical areas is reduced, consideration should be given to the use of the typical size beam section with a reduction in the number of studs. The simpler the framing, the lower the final estimated cost is likely to be at bid time and, as a result, the lower the total square foot cost of the project.

Use live load reductions for the design of members where possible. While live load reduction may not result in any substantial reduction in filler beam weights, a change of one size, perhaps a reduction from a W16x31 to a W16x26, will result in a 16% savings in the filler beam mill material required. The savings in girder and column weights and the cost of foundations are likely to be significant.

The level of inspection specified should be consistent with that required to insure that the completed structure will be functional. Except in unusual circumstances, visual inspection should be adequate for fillet welds. The extent of nondestructive testing of butt welds may be finally determined during the construction period. If the results of tests are marginal, the number of tests can be increased. If the results of the tests are consistently good, the number of tests may be reduced. Especially for large projects, it may be prudent to require AISC certified fabricators in order to insure good quality control and a more trouble-free project.

Finally, paint only members required by the AISC Specification. Unpainted surfaces should be used when in contact with concrete. Fireproofing material more readily adheres to unpainted surfaces. While painting costs may only be $.15 to $.20 per square foot, for a 200,000 square foot project the cost saving of $30,000 to $40,000 is real and is there for the taking.

LIVE LOAD AND BAY SIZE SELECTION

Most buildings are economic machines of one sort or another. In particular, many office building structures are built on a speculative basis. The success of the venture may be a function of the building's planning and serviceability potential. Larger bay sizes increase the flexibility in space planning. Higher design live loads also increase the flexibility in the uses permitted in office space. Buildings with higher live load capacities and larger bay sizes are obviously more attractive to potential building tenants and more valuable to building owners. It will be shown that larger bay sizes and higher