Discussion

Mill Building Design Procedure

Paper presented by JOHN F. BAKOTA
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Discussion by **C. F. Diefenderfer**

Mr. Bakota has included in his references many of the universally accepted articles on this subject. However, the Association of Iron and Steel Engineers publication *Specifications for the Design & Construction of Mill Buildings* is not mentioned in the article or references. A discussion of Mr. Bakota's article follows, with emphasis that the AISE specification will provide the guidance he was seeking.

Mr. Bakota is quite correct when he states, "The design of an industrial mill building involves myriad assumptions and parameters." The Association of Iron and Steel Engineers, recognizing the need to consolidate available information and to guide designers, contractors, and suppliers to the building requirements of the steel industry, established a subcommittee for the design and construction of mill buildings in the mid-sixties, under the chairmanship of the late John J. Murray. AISE Standard No. 13, *Specifications for the Design and Construction of Mill Buildings,* was issued by the Association in 1969. As stated in Sect. 1.1, "This specification provides owners, engineers and contractors with a comprehensive and rational approach to the design and construction of mill buildings and other buildings or structures having related or similar usage."

This specification guides the owner and designer through the questions and problems presented by Mr. Bakota. It suggests minimum floor loads and offers wind load factors for determining average normal pressures on walls and roofs, in accordance with ANSI and ASCE wind studies. It lists load combinations for the design of crane runways and supporting structures, including the foundations.

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The specification requires a continuous bracing system in the plane of the bottom chords of the roof trusses. Transverse shears are to be distributed to the columns in proportion to their stiffness in that direction.

Guidance is given for the combined stress evaluation in crane girders from simultaneous vertical and lateral loading. It indicates when fatigue provisions should be applied.

Information is given for soil investigation, earthwork, and excavation requirements. General criteria and procedures for the design of mill building foundation components are included. Information on electrical grounding of the structural frame and general illumination levels for various operations is presented.

In general, this specification provides the parameters and guidance for the design and construction of mill buildings that Mr. Bakota was seeking. It is an excellent reference for all engineers involved in industrial buildings.

Mr. Bakota recommends independent action of the crane and building shafts for type (b) columns of his Fig. 1. There is limited data, both theoretical and experimental, that supports integral action of these shafts, provided there is a stiff connection between the top and bottom of the segments and adequate diaphragms between them to resist the shear flow (VQ/I). Using the integral assumption, more economical columns are achieved, especially where the transverse forces are larger than those in the example. The AISE standard recognizes such an analysis. With this assumption, one must include the eccentric load of the crane girder reaction about the strong axis of the combined shaft. This adds to the moment forces being analyzed.

In the design of the crane girder, the moment from lateral force should be 21.4 kip-ft, using the AISC recommended value for lateral force on crane runways. This lateral force is one of three criteria for side force given in the AISE standard. Carrying that correction through, a designer might accept a W24x120 as being adequate, even though the sum of the combined stresses will exceed 24 ksi by about 2%. However, this section, selected utilizing Gaylord's liberal assumption, would not be in conformance with the AISE standard. In heavy duty operation, it is desirable to have a relatively stiff horizontal resistance at the crane girder level to maintain gage of the crane rails and minimize wear on the rail and wheels. Thus, the designer familiar with heavy duty service requirements will select a section that satisfies the more general requirement of $f_{bx}/F_{bx} + f_{by}/F_{by} \leq 1$.

Some mention should be made in the example concerning the fatigue life of the crane girder and its support. In this particular case, the indicated stress range of the W24x120 plain beam without any attachments should provide a life of 2×10^6 cycles of loading. This is generally considered adequate. However, a caution against welding any attachments to the girder in the tension region should be made in order to maintain the fatigue life of the chosen section in this high stress range.

Mr. Bakota's conclusions are the best advice to all designers. The designer must determine if the assumptions of any analysis are valid for his particular structure before he utilizes them.