GINZEL

Design for a Grand Stand

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DESIGN
FOR A
GRAND STAND

...BY...

Carl Louis Ginzel

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

CARL LOUIS GINZEL

ENTITLED  DESIGN FOR A STEEL-FRAME GRAND STAND

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

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HEAD OF DEPARTMENT OF Civil Engineering

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Introduction.

There are few grand stands in existence that are made entirely of steel. The writer, after a search through the University of Illinois library, has found only two articles concerning steel grand stands which have been built previous to the year of 1903. One of these articles describes a grand stand erected at Hummashop Park, N. J., and the other concerns a somewhat similar structure at Yonker, N. Y. The writer has personally visited the grand stand at Delmar Race Track at St. Louis, Mo., which with the exception of the seats and the columns supporting them, is made of steel.

Object.

The object of this thesis is to design a fire-proof grand stand, the framework to be made entirely of steel and to be designed according to the specifications.
found in Ketchum's Steel Mill Buildings. It is the purpose to design a structure that may be economically constructed.

Location.

In view of the necessity of having a grand stand at the University of Illinois, the writer has considered Illinois Field as being the probable location of this design. A contour map was made as the grounds are practically level and no excavation is necessary except for the column footings.

At the above location it would be better to build a grand stand having a single rather than a double tier of seats. In the first place a structure with two tiers of seats would be constructed only in case there is limited space upon which to build, or where the land is so expensive as to warrant the saving of space by increasing the height. Neither of the above conditions occur at Illinois Field. Unless the width be made small, two-tier
of seats at a slant of one to three would necessitate too great a height to be practical, while a less pitch would be inadvisable on account of the probability of one person obstructing the view of the person seated directly behind him. Although a two-story structure requires only one roof, the wind acting upon it at such a great height causes excessive bending moment in the columns. The latter, together with the weight of an extra tier of seats, requires the seat trusses and columns to be made so much heavier as to compensate for the extra expense for the roof in a one-story structure. The writer, after making a rough estimate of the relative cost of a one and of a two-story structure, concluded that the former would be the more economical.

The Design.

The grand stand here proposed is made up of eight fifty-foot sections which are identical. It is therefore necessary to de-
scribe only one of these sections.

The roof truss is of the simple Thiers type. In the rear a column supports each truss, but in front only every third truss rests on a column. The object is to have as few obstructions as possible in front to obscure the view of the people in the seats. A beam of built-up section supports the front ends of the intermediate trusses. The justins are placed at the panel points of these trusses, and support a roofing made of corrugated steel which is fastened by means of clinch nails. For details of the roof trusses, the roofing, and the columns see Plate 2. For the general dimensions see Plate 3.

The single tier of seats rests upon steel columns. To resist the wind, a system of sway bracing is placed between these columns, the rear columns being braced both longitudinally and transversely. For details of seats and bracings see Plate 2.

The foundations are made of concrete shaped like the frustum of a pyramid.
For details see Plate 3.

To resist the wind on the gable end of the roof, bracing is placed between the two roof trusses at each end of the structure, in the planes of their upper chords. The purlins act as struts to transfer the wind stresses to the lateral bracing.

In determining the stresses in the columns and trusses the following assumptions were made: that the rear columns are fixed by the seats; that they take up all the bending due to wind; that the front columns are not fixed and that the reactions upon them due to the wind are vertical.

The wind stresses are calculated graphically. For stresses see Plate 1. The members are designed according to the specifications found in Ketchum’s Steel Mill Buildings. Tension members are designed to take a stress of 16,000# per square inch of net section. The allowable unit stress for compression members is given by the following formula:
\[ P = 16000 - 70 \frac{1}{r} \]

\[ P = \text{Allowable stress per square inch.} \]
\[ l = \text{Length of member in inches.} \]
\[ r = \text{Least radius of gyration.} \]

No metal less than \( \frac{1}{4} \) inch in thickness is used. The minimum size of angles used is \( 2'' \times 2'' \times \frac{1}{4} '' \), which in several members gives an excess of metal, but it would be impractical to use shapes with a smaller section in so large a structure.

In the above design the writer does not go into minute details. Only the most essential features are described, with a view of giving a general idea of the construction and methods employed.