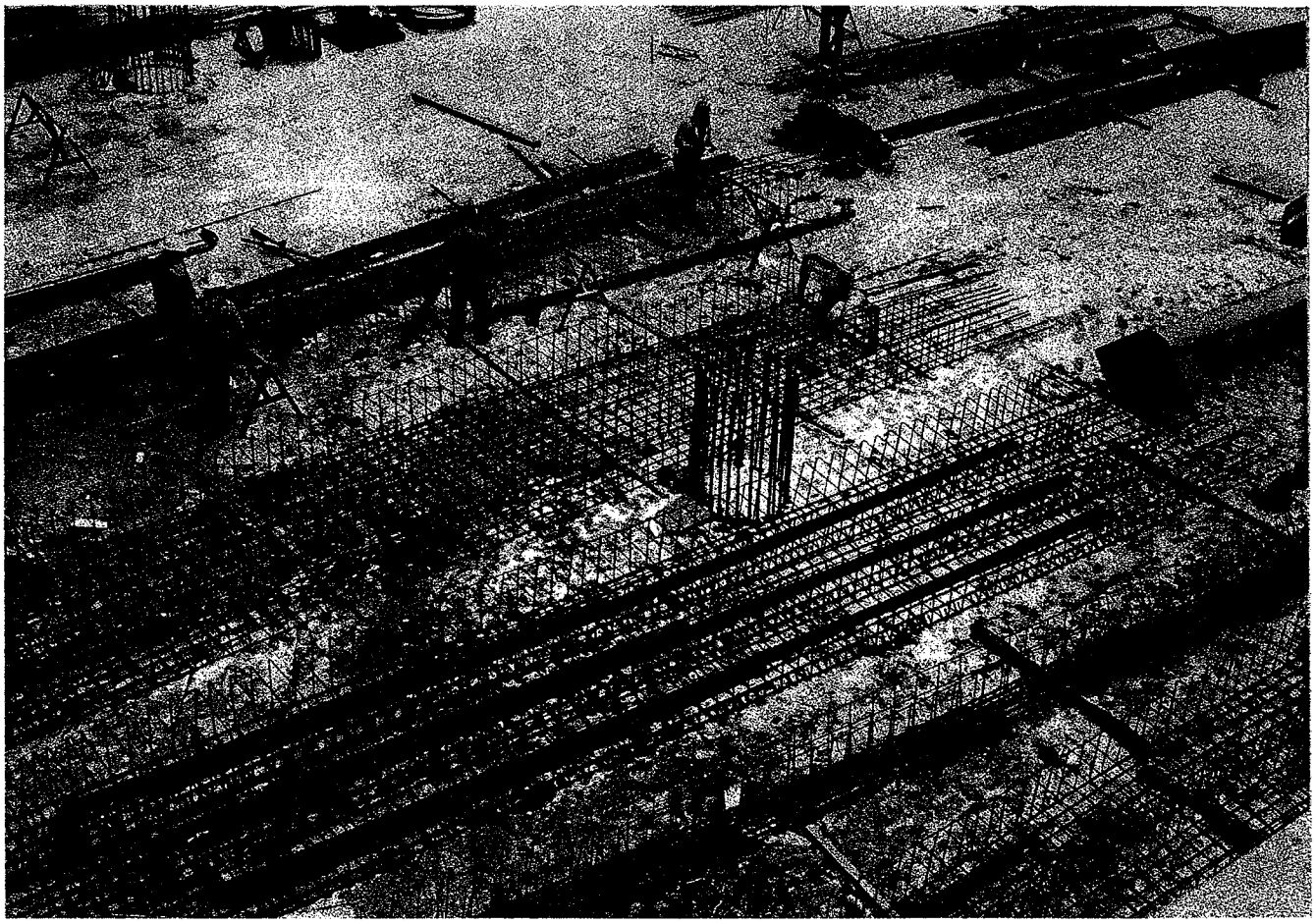
Reinforcing Steel Placement — Why Should We Be Concerned?

by Thomas M. Lamb



Many errors and omissions in reinforcing steel placement go unnoticed during construction of concrete buildings. This article traces deficiencies to budget constraints and compressed time schedules. To alleviate significant reinforcing steel errors and omissions, owners and designers must be educated on the importance of thorough reinforcing steel observations.

Keywords: concrete construction; errors; inspection; **reinforcing steels.**

Reinforcing steel placement is often not thoroughly observed and documented on construction projects. Limited funds are typically allocated by the owner for this purpose, and it is not always certain which members of the construction team, if any, have contractual or professional obligations to document steel placement.

After concrete placement, the errors and omissions are encased in a mass of hardened concrete, thus creating an unknown potential for costly repairs and/or building failure. In the interest of public safety and protecting the owner's investment, thorough field observation of reinforcing steel should be considered a necessity.

Historically, when observations of in-place reinforcing steel have been made on projects either the structural engineer, architect, contractor, or an independent testing laboratory performed the work. However, since present-day owners typically have great budget constraints, they usually limit the individuals assigned the responsibility to document steel placement to only a brief or cursory review.

To comply with the structural drawings, the correct number of bars, bar size, bar length, and cover must be present throughout the structure. Unfortunately, a brief review of reinforcement steel placement is insufficient to ade-

quately document the many important placement details.

Thorough review

At the request of concerned owners, thorough field review of steel reinforcement has been provided in certain cases. The reinforcing steel in each structural member is observed by an experienced engineer prior to concrete placement, documenting bar size, length, configuration, and other details necessary to judge substantial compliance with the project drawings. Through this process, many steel placement errors and omissions have been documented.

Minor variations in bar spacing, cover, and splicing length are some of the deficiencies commonly observed. However, deficiencies of much greater concern are occurring on projects. Some examples of these errors and omissions are listed below.

It should be recognized that errors and omissions of this magnitude should not be considered unusual and frequently occur on project sites.

1) Improper bending of bars — The off-set bend for column vertical steel in the transition zone between two levels was miscalculated by the steel fabricator. This resulted in the congestion of dowels near the center in the next level of columns.

2) Missing bars — In a flat plate system, all of the required twelve #6 bottom bars were found missing in a column band.

3) Incomplete drawings — In a pan and joist slab, reinforcing steel at four adjacent joists was placed per approved shop and structural drawings. However, both drawings omitted top bars at one end of the joists.

4) Preassembled reinforcement — In a column, approximately 30 percent of the required twelve #7 vertical bars were found missing. The column cages had been fabricated correctly at an off-site location with grid locations marked on each cage. However, some of the grid locations were incorrect and the cages were placed at the wrong grid locations.

5) Reversed bars — The top and bottom stairway dowels for a reinforced concrete stairway were found to be reversed, creating a situation where the top bars were only half the specified length.

Placement problems

How do reinforcing steel deficiencies occur? The most obvious reason is a result of construction progressing at a faster pace to meet compressed time schedules. However, many times reinforcing steel placement errors occur from improper details or instructions. The following list presents some of the causes for reinforcing steel misplacement and omissions:

1) Poorly detailed shop drawings and/or structural drawings — In projects where drawings are produced under compressed time schedules, documents used for the actual construction often contain a number of unclear or incomplete details. Drawings generated in this manner establish a condition where steel placement may be left to the knowledge and experience of the contractor. Alternately, the contractor may contact the structural engineer for clarification; this results in construction time delays.

2) Inadequate checking of shop drawings — Historically, it has been the responsibility of the structural engineer to review and approve the shop drawings. Again, compressed time schedules may result in major errors remaining undetected during the review process. Failure to detect errors or omissions in shop drawings has indirectly placed more responsibility on the shop detailer.

3) Unapproved or superseded plans — It is not uncommon in today's construction industry to work from drawings which have not been reviewed and approved by the structural engineer. Unfortunately, it is not unusual to have final approved drawings available only after the concrete has been placed.

4) Unanticipated field changes — If the shop drawings do not include the proper details/instructions, changes in reinforcement location may occur when box-outs or embedded items interfere with the required reinforcement steel. Relocation procedures resulting from congestion or interference should be reviewed by the structural engineer to judge compatibility with the original design. However, due to time constraints, the structural engineer is not consulted in some cases.

Conclusions

In today's construction industry, the owner must be educated on the importance of thorough field documentation of reinforcing steel. With adequate funding, the construction team can arrange for an engineer to observe all reinforcing steel at each structural member well ahead of concrete placement.

To accomplish this task, the appropriate sequence of structural and shop drawing review must be completed to provide the engineer with an approved, accurate drawing from which to perform the observations. If these guidelines are followed, major reinforcing steel deficiencies and omissions will be minimized in the construction industry.

Thomas M. Lamb *is a civil engineer with Twin City Testing and Engineering Laboratory, Inc., St. Paul, Minn. A graduate of the University of Minnesota, he has been involved in testing and engineering on numerous construction projects in the Minneapolis-St. Paul area since joining the firm four years ago. One of these projects was the new Humphrey Metrodome where he spent one year exclusively documenting and observing reinforcing steel layouts.*