LIFTING TILT-UP PANELS

TILT-UP CONCRETE ASSOCIATION

PICK-UP POINT DESIGN SERVICE

Factors Involved

The choice of inserts and the analysis of their location must take into consideration all the design problems involved in erecting the panel. The success of tilt-up as a construction method is based on the safe and economical execution of the erection procedure. When lifting a panel from horizontal to vertical, it undergoes more stress in those few minutes than it will ever encounter as a structural unit. Those stresses can run as much as four times the expected structural stresses. The correct location of the inserts is the major factor determining whether a panel is raised perfectly unblemished or whether it is damaged by stress cracks.

Pick-up Points

Meadow Burke engineers have refined the location of pick-up points into a science. It involves the delicate balancing of negative cantilever moments and the positive moments between pick-up points. This correct placement minimizes flexural stresses in the panel.

Selection of the proper insert location is complicated by the fact that the stresses within the panel vary continuously as the panel is rotated from horizontal to vertical. Meadow Burke's computerized mathematical rotation analysis has been derived from years of experience and consultation with nearly a dozen top flight engineers and mathematicians at four of the nation's leading universities.

The balancing of the bending moments requires the further consideration of the tensile and compressive strengths of the concrete. Because of this consideration, Meadow Burke bases its analysis on the modulus of rupture of concrete. The tensile strength of the concrete on one face and the compressive strength on the opposite face resist the creation of cracks in the concrete during erection. Depending on whether the bending moment is either positive or negative, the compressive and tensile stresses will alternate in different places on both faces of the panel. The effect of thermal reinforcing steel is usually discounted in the analysis of the lifting stresses. Because this reinforcing is placed in the center, the panel would develop serious cracks if raised prior to the concrete reaching the minimum tensile and compressive strengths. If the modulus of rupture is low, the panel will crack to the steel reinforcing during the erection procedure. This is, of course, unacceptable. The cracking could be minimized by placing curtains of steel on both the top and bottom faces of the panels. Not only would this be uneconomical, it would not entirely eliminate unwelcome cracks in the panels.

Concrete Strengths

Meadow Burke engineers have found, from over forty years of experience, a minimum compressive strength of 2500 psi (17.2 MPa) and a modulus of rupture of 500 psi (3.4 MPa) are required for crack-free erection of tilt-up panels. It is assumed that the allowable tensile strength will be 60% of the modulus of rupture. Meadow Burke Engineers recommend that a Test Beam Break (ASTM Designation: C 78) be undertaken, along with the more common concrete cylinder compression tests prior to erection.

MEADOW BURKE ENGINEERING IS THE CONTRACTORS ADVANTAGE

Advantages

By far, the most crucial phase of tilt-up construction is the erection of wall panels. It is during this important phase that the economics of tilt-up construction become most obvious.

This critical lifting phase is in many ways a test of all the labor that led to the erection of the panels. If anything has been done incorrectly, it will probably show up during this phase. If the bond breaker is inadequate, the panels will stick to the surface. If the inserts have been incorrectly placed, the panel may crack and the inserts may be overloaded. It is at this point that a contractor appreciates the insert design of Meadow Burke's Engineering Department and the use of reliable products.

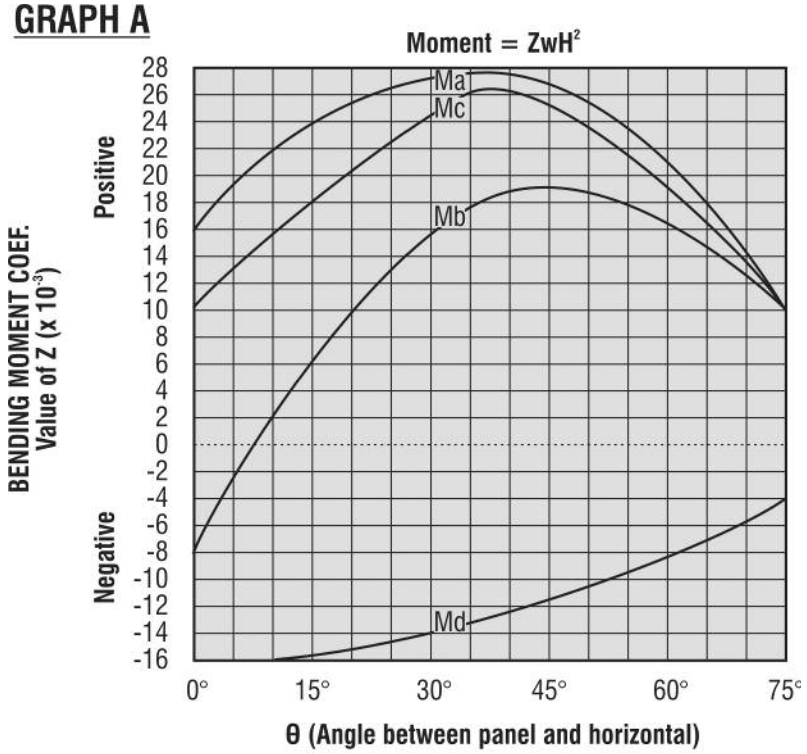
The pull of gravity exerts unusually high stresses on the panel as it is slowly rotated into an upright position. At a time when the panel is not yet at full strength, it will be momentarily subjected to maximal stresses. At this critical point, the panel may receive as much as four times the stress it is likely to encounter as a structural unit.

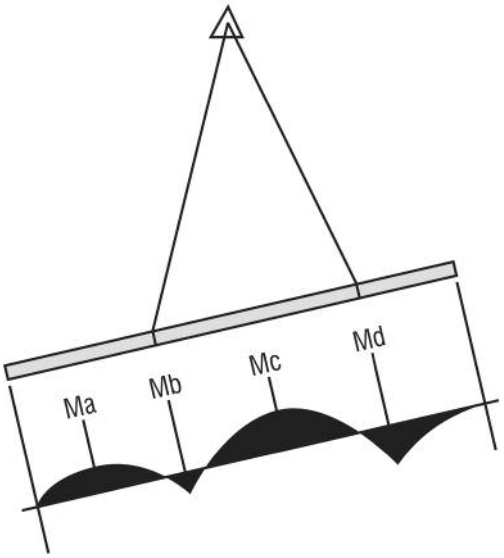
As the panel is rotated from 0° to 90° the overall stress reaches its maximum at a number of critical angles. This will vary with the shape of the panel and the type of rigging used. Graphs A and B (see page 22), produced by Meadow Burke Engineering, illustrate the changing, bending moments during panel rotation. They illustrate the effect of various rigging configurations on a rectangular panel.

Notice that the angles of maximum stress vary for the two rigging configurations. For "two-high rigging", the point of maximum stress occurs at approximately 40°. For "four-high rigging", the stresses peak between 45°- 60°. Cracking and failure are most likely to occur at these angles. As the panel is rotated, tension and shear loads will vary. Generally, tension loading will decrease while shear loading increases until the panel is vertical. Impact loading will occur throughout the lifting sequence and under normal conditions will be absorbed by the safety factor. But, if the panel drops and is suddenly caught by the crane, or if the panel hits the boom of the crane, unusually high impact loading will be exerted on the insert. Under these conditions of unusual stress, the quality of lifting equipment is paramount. Meadow Burke matches its respected engineering service with a comprehensive line of lifting equipment, including a ground release system.

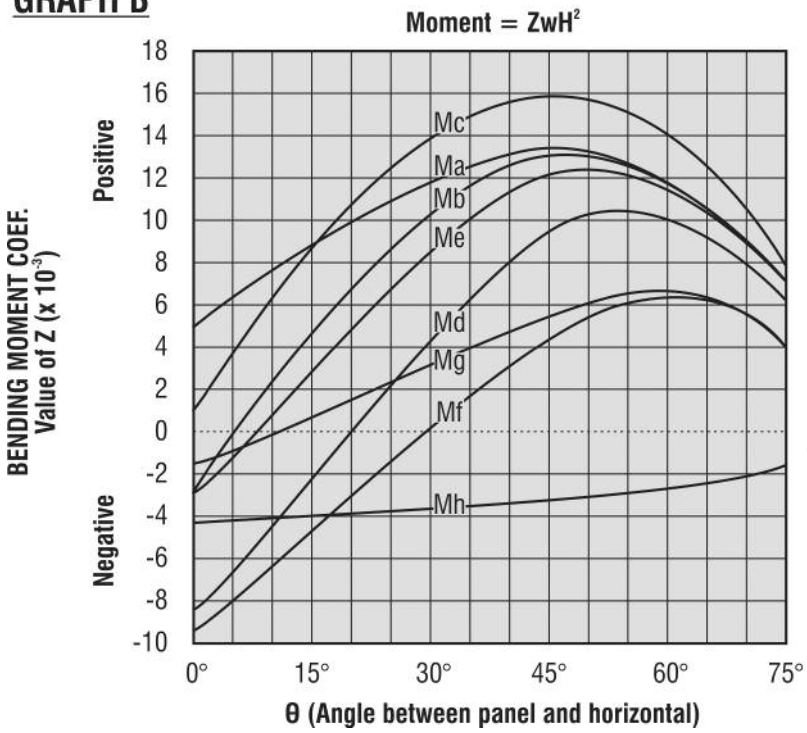
BENDING MOMENTS DURING ROTATION

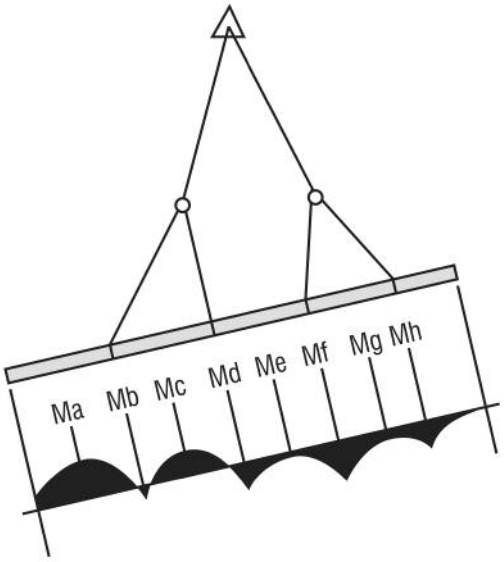
GRAPH A





GRAPH B





MEADOW BURKE ANALYSIS PROGRAM

Stress Analysis

Meadow Burke's full-time programmers have developed an iterative and interactive tilt-up program to efficiently plot safe lift points and calculate the various flexural and shear stresses. Once the computer has calculated preliminary information such as the weight and center of gravity of the panel, it launches into a full rotation analysis. The "mind" of the computer simulates the lifting of the panel and calculates the shear stresses and bending moments at approximately every 3° of rotation. It follows the panel through all the critical stages of erection. Any potential weak point in the panel during erection will be spotted and the inserts moved to compensate. Though each calculation takes but a microsecond, it is executed with space age certainty. The computer will erect the building in its memory banks long before a single panel is ever poured. Once the optimal insert location is determined, the accurate scale drawings are produced for each panel on a laser printer. If supportive reinforcement or strongbacks are determined to be necessary, they will be specified.

Brace Analysis

Engineering can also provide an accurate analysis and location of the required bracing. Brace information can be located on the same erection drawing.

Meadow Burke's Engineering staff aims at maximum certainty and the elimination of chance at the work site. It is for this reason that insert location for bracing and rigging details should be adhered to exactly. Any desired changes in the location and placement of inserts should be analyzed and cleared by Meadow Burke's Engineering staff before being carried out in the field. If a critical problem develops during the lifting sequence, Meadow Burke's Tilt-up Engineering can provide instantaneous computer analysis.

Engineering Response

The fastest service from Meadow Burke Engineering can be obtained by submitting a complete set of plans, complete submittals and P. O. at the beginning of the project, rather than sending the information in pieces. Send the plans to your designated Engineering Office so they will not be delayed by transferring them to another location.

When calling to discuss a project once the engineering has been completed, have the job number available, as the details are filed by job number.

Engineering Service

All insert location design work is done according to the expressed preferences of the contractor unless these are impossible or unsafe. If this is the case, Meadow Burke's Tilt-up Engineering Center will contact the contractor and suggest changes. Make full use of the Meadow Burke Distributor and Engineering staff. Their time will save you money. We urge you to contact our tilt-up specialists no matter what the stage or status of your project.

Panel Detail Books

Engineering distributes completed detail books but retains plans so that changes can be noted and plans referred to if necessary. Plans are kept for three months after details are completed and then discarded unless their return is requested by the customer.

NOTES