A STUDY OF ALTERNATE METHODS OF CONSTRUCTION OF THE ACCELERATOR HOUSING

REPORT TO PROJECT M - NO. ABA-38

STANFORD UNIVERSITY SUBCONTRACT S-128

UNDER AEC CONTRACT AT(04-3)-363

SUBMITTED BY H H Gilbert APPROVED BY R L Sharpe

AETRON-BLUME-ATKINSON
A Joint Venture
ARCHITECT-ENGINEER-MANAGER
1455 California Avenue
Palo Alto, California

February 1962

STANFORD LINEAR ACCELERATOR M

A STUDY OF ALTERNATE METHODS OF CONSTRUCTION OF THE ACCELERATOR HOUSING

INTRODUCTION

This progress report presents a summary of studies made to date of different materials and methods for constructing the Accelerator Housing. Studies are continuing and the final recommendations will not be presented until After April 1, 1962.

Two basic materials were considered for use in construction of the Accelerator Housing - steel and reinforced concrete. Steel was discarded early because of several factors: (1) high cost, (2) maintenance problems due to possible corrosion, and (3) inefficiency of cross sectional area - tubular or elliptical shaped cross section is most economical for steel. Use of reinforced Portland Cement concrete for the housing structure is considered to be the most satisfactory material from a practical and economical standpoint.

CONCRETE CONSTRUCTION METHODS

Five different methods of construction, using reinforced concrete, have been considered and are discussed in this report. They are:

I. Precast Conventional Reinforced Concrete

II. Precast Prestressed Concrete

III. Precast Post-tensioned Concrete

IV. Poured-in-place Post-tensioned Concrete

V. Poured-in-place Conventional Reinforced Concrete

Method II - Precast Prestressed Concrete: This method using prestressing, for each short concrete section of housing, has all the drawbacks of Method I with the addition of being more costly. The use of prestressing steel will give slightly less concrete thicknesses in the walls and slabs resulting in little longer casting sections than the 3 foot length considered for Method I. This improvement is not great enough to place Method II into a category that could be recommended.

Method III - Precast Post-tensioned Concrete: This method has the same objections as to handling and placing as the two previous methods using short pre-cast sections. Post tensioning a number of these short sections together would require the placing of tubes or conduits in the sections before pouring the concrete. After these sections were in place, tensioning strands would be threaded through the conduits and tensioned by jacking against the end sections. This would cause the entire string of concrete sections to act as a beam to resist unequal settlement and misalignment. However, the excessive number of transverse joints, which have to be made watertight, makes this method economically impractical and is not recommended.

Method IV - Poured-in-place Post-tensioned Concrete: This method is similar to Method III as far as the post-tensioning is concerned but instead of precasting short sections, this scheme would involve pouring the concrete in the housing, in its final location as "Pouredin-place Concrete". The housing could be poured in long lengths such as 100 feet, with waterstops placed, embedded in concrete, in the joints between adjacent sections. Conduits with the tensioning strands anchored at one end would be placed before pouring the concrete. After the concrete has attained the required strength the strands would be tensioned at one end by the use of jacks. Finally after anchoring the strands at the jacking end, the voids in the conduits would be filled by pumping in cement grout under pressure. This method of construction would result in a rigid structure which would be resistant to lateral movement, which might cause cracking

Method I - Precast Conventional Reinforced Concrete: This method consists of casting short sections of the housing on site using a specially prepared casting yard. This work could be started prior to the time the site preparation is completed. Since these sections will weigh close to 8½ tons per foot of length, it will be impractical to handle a section longer than about 3 feet. This means that there will be over 3000 transverse joints in the length of the housing. To make these joints permanently watertight is practically impossible. Besides requiring heavy equipment to handle these sections, it is necessary to construct casting beds, together with storage areas located in close proximity to the final position of the accelerator housing. In order to insure continuous pouring of the concrete in these sections, it is necessary to have sufficient forms to allow the concrete to cure before removing them for future use. These forms must be substantially built as they will be used many times, and their cost must be considered when comparing this method of construction with others. Another serious objection to placing precast sections is that it is very difficult to prevent misalignment due to differential settlement between adjacent sections and the resultant misalignment of the accelerator pipe. In addition, the joints between the sections could open up and destroy the watertight integrity of the housing.All of these factors tend to make this method more costly and less reliable than other methods of construction. The one favorable factor in the use of Method I for construction of the accelerator, lies in the fact that the casting and curing of the concrete can proceed at the same time the excavation and fill is made. This advantage is far outweighed by the objections to this method as previously indicated.

for areas where the foundation material varies in bearing capacity. At points where there is a transition from cut to fill or vice versa this method of construction would help to prevent unequal settlement and consequent vertical misalignment. Although this method of construction is more costly than using conventional steel for the longitudinal reinforcement, as will be discussed under Method V, it may be justified at certain places to prevent excessive cracks in the housing or misalignment of the accelerator pipe due to unequal settlement. The sections in this method would be poured consecutively from one end in order to have space for the jacking operation. This method would result in long delays between pours as the concrete has to reach considerable strength before the tensioning operation can be made. Another means of post tensioning is being studied whereby construction time could be reduced to be more comparable with conventional reinforced poured-in-place construction.

Method V - Poured-in-place Conventional Reinforced Concrete: This method consists of using poured-in-place concrete with rebar reinforcement for both the longitudinal and transverse directions. The housing would be poured continuous in lengths from 50 to 75 feet, with poured-in-place water stops in the joints between sections. This length is somewhat shorter than required in Method IV, to minimize shrinkage cracks. The post-tensioning in Method IV has a tendency to close the shrinkage cracks resulting in a longer section between joints. Method V is the most economical method of all the methods discussed and should be used where possible. Present studies are being made considering the use of a modified Method IV for certain areas and Method V for others. These studies include the effects on construction time, relative cost, and structural integrity and other factors.

pcw