ECONOMIC COMPARISON OF ON-SITE VERSUS OFF-SITE CONCRETE PLANT

REPORT TO STANFORD LINEAR ACCELERATOR CENTER - ABA No. 78

STANFORD UNIVERSITY SUBCONTRACT S-136

UNDER AEC CONTRACT AT(04-3)-400

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INTRODUCTION

In support of ABA's recommendation that a concrete plant be established on site, the economics associated with an on-site batch plant, as presently specified in Division 3, Section 3c-Concrete, paragraph 6 - Mixing and Batching, of the Technical Specifications for Contract 501-2, have been analyzed. The results and conclusions of this review are presented in the following pages and are summarized in Table I.

Section A of this Report, "On-Site Versus Off-Site Concrete Plant", indicates an on-site cost advantage of approximately $1.65 per cubic yard. The technical advantages of such a plant have been discussed in previous meetings and documents, refer specifically to ABA Report No. 68, "Considerations in Design of the Accelerator Housing" and letter from G. Bawden to K. Copenhagen, dated 24 May 1963.

Sections B and C, "Cost of Land Use" and Water and Power Cost", summarize costs which would be chargeable to the contractor if concrete is supplied to other on-site contractors. Based on the results of this analysis, it is recommended that a charge of $0.07 per cubic yard be included for land use and utilities and $0.04 be charged for each cubic yard of cooled concrete.

TABLE I

ECONOMIC COMPARISON SUMMARY

A. ON-SITE VERSUS OFF-SITE CONCRETE PLANT

	Premium Cost/CY On-Site	Off-Site
1. On-Site Concrete Plant Mobilization	$ 0.63	
2. Off-Site Plant Modifications		$ 0.25
3. Off-Site Concrete Haul		1.80
4. Off-Site Truck Breakdown		0.18
5. Off-Site Plant Control		0.05
6. Plant Utilities	No Difference	
	$ 0.63	$2.28
Net Cost For Off-Site Plant		$1.65/CY

B. COST OF LAND USE

Contractor use of 75,000 sq. ft. at Site	$0.04/CY

C. COST OF WATER AND POWER

1. Water For Concrete Plant	$0.01/CY
2. Power for Concrete Plant	0.02/CY
Total Water and Power - No Cooling	$0.03/CY
3. Power for Cooling Plant	$0.04/CY

A. ON-SITE VERSUS OFF-SITE CONCRETE PLANT

The considerations used in the evaluation of an on-site versus an off-site concrete plant are summarized in the following paragraphs.

1. On-Site Concrete Plant Mobilization

The cost to move in, setup and move out a concrete plant with capacity of 60 CY/Hr is estimated to be $25,000. This figure does not include the actual cost of the plant. If 40,000 cubic yards is assumed for Housing concrete requirements, then the on-site concrete plant would incur a premium cost of $\frac{\$25,000}{40,000\ CY} = \$0.625/CY$

2. Off-Site Plant Modifications

Additions and modifications to off-site plants would be required to meet the low shrinkage aggregate batching requirement. Additional off-site maintenance would also be involved to keep older plants in operation with the hard granite rock. The off-site cost has been assumed to be $10,000. $\frac{\$10,000}{40,000\ CY} = \$0.25/CY$

3. Off-Site Concrete Haul

If an off-site plant were used, there would be a haul distance premium cost associated with the travel time. Assuming a 6 mile distance from the plant to the SLAC site entrance, 20 mph average speed, 5 cubic yard truck load, and a truck with operator cost of $15 per hour, the off-site cost would be:

$$\frac{12\ miles \times \$15/hr}{20\ mph \times 5\ CY} = \$1.80/CY$$

No cost has been included for delays due to traffic congestion during rush-hours. It has been optimistically assumed that the contractor will schedule his concrete placement so as to avoid unusual delays.

4. Off-Site Truck Breakdown

Based on an estimated peak concrete placement of 2000 CY per week, approximately 400 truck loads will be hauled to the site per week. It has been estimated by Atkinson personnel, based on experience, that one truck in 50 will breakdown. (8 loads out of 400 loads per week.) Assuming that half the trucks are loaded and this concrete (at $18/CY) is wasted after truck breakdown, the off-site cost would be:

$$\frac{4 \text{ loads/wk} \times 5 \text{ CY/load} \times \$18/\text{CY}}{2000 \text{ CY/week}} = \$0.18/\text{CY}$$

It should be noted that with a longer off-site haul, more trucks will be required with a higher probability of breakdown.

5. Off-Site Plant Control

To assure continuous concrete delivery on the tight placing schedule required, radio control would be necessary between the headings and an off-site plant. Assuming the cost of such a radio installation to be $2000, the off-site premium cost would be

$$\frac{\$2000}{40{,}000 \text{ CY}} = \$0.05/\text{CY}$$

No salvage is assumed as the useful life of such equipment under rough handling is about two years. It is quite possible this cost could be much higher, depending on distance to the off-site plant.

6. Plant Utilities

It is assumed that there is no difference in cost to the contractor between on-site and off-site utilities. On-site utilities are calculated in Section C of this report.

B. COST OF LAND USE

1. Assume comparable commercial use land value of $0.50/square foot.
2. Assume a 1%/month rental charge.
3. Concrete volume for Housing 40,000 cubic yards.
4. Construction schedule of 15 months.
5. Area occupied including stockpiles and storage 250' x 300' = 75,000 ft^2.
6. Klystron Gallery concrete volume 10,000 cubic yards.

$$75{,}000\ ft^2 \times \$0.50/ft^2 = \$37{,}500 \text{ (value of land)}$$

$$\$37{,}500 \times 1\%/\text{month} = \$375/\text{month}$$

$$\frac{\$375/\text{mo} \times 15\ \text{mo}}{40{,}000\ \text{CY}} = \underline{\$0.14/\text{cubic yard}}$$

If Gallery concrete, Central Lab and Heavy Assembly (approximately 20,000 cubic yards) is included and 4 more months of operation,

$$\frac{\$375/\text{mo} \times 19\ \text{mo}}{60{,}000\ \text{CY}} = \$0.12/\ \text{CY}^*$$

*However, 40,000 cubic yards or 2/3 is chargeable to the Main Housing contract. Therefore, cost of land use for concrete furnished to other contracts should be $0.04 per cubic yard

$$(\$0.12 - 2/3 \times 0.12) = \underline{\$0.04/\text{CY}}$$

C. WATER AND POWER COST

1. Water for Concrete Plant

Water for the concrete plant will come from the SLAC (Menlo Park) System for which the following rates are established:

1st	333 units	@ $0.240
next	3000 "	0.220
	10,000	0.190
	26,667	0.160
	40,000	0.155
	80,000	0.153
Over	160,000	0.148

Add $0.01 per unit for service demand per month. (one unit equals 100 cubic feet.)

a. Water required for mixing concrete is assumed at an average of 240 lbs/CY.

$$\frac{240 \text{ lbs/CY} \times 0.1198 \text{ gal/lb}}{748 \text{ gal/unit}} = 0.0385 \text{ units/CY}$$

Assume $0.190 bracket

$0.190/unit x 0.0385 units/CY = $0.0073/CY

Add service demand cost

0.0385 units/CY x $0.01/unit = $0.0004/CY

$0.0077/CY

b. Assume washdown and waste 5 gal/CY

$$\frac{5 \text{ gal/CY}}{748 \text{ gal/unit}} = 0.0068 \text{ units/CY}$$

(0.190 + 0.01) x 0.0068 units/CY = $0.0014/CY

c. Assume water for cooling aggregate 16 gal/hr. For a daily production of 200 CY this amounts to approximately one gallon per CY.

$$\frac{1 \text{ gal/CY}}{748 \text{ gal/unit}} \times \$0.20/\text{unit} = \$0.0003/\text{CY}$$

d. Summary - The cost of water required for use by an on-site concrete plant is estimated to be $0.0094 per cubic yard of concrete. Say $0.01/CY

2. Power for Concrete Plant

Assume a 2 cubic yard tilting mixer @ approximately 40 HP

7½ - 10 HP Air Compressor

5 HP Cement Screw

5 HP Batch Screw

7½ - 10 HP Cement Elevator

Assume that the plant will require 40 HP continuously based on intermittent demand of batching equipment and operation of the mixer about 50% of the time, with an 80% motor efficiency and power factor, the power used would be

$$\frac{40 \text{ HP} \times 0.746 \text{ KWH/HPH}}{40 \text{ CY/Hr} \times 0.80 \text{ PF} \times 0.80} = 1.17 \text{ KWH/CY}$$

Assume that a 10 HP motor driven conveyor will be used to handle the aggregate

$$\frac{10 \text{ HP} \times 0.746 \text{ KWH/HPH}}{40 \text{ CY/Hr} \times 0.80 \times 0.80} = 0.29 \text{ KWH/CY}$$

TOTAL POWER = 1.46 KWH/CY

P G & E Rate Schedule A13(4)

1st 50	KWH/KW demand	$ 0.0222
next 150	"	0.0128
next 100	"	0.0091
over 300	"	0.0065

Assume a rate of $0.0128

$0.0128 x 1.46 KWH/CY = $0.0187/CY

SAY = $0.02/CY

3. Power for Concrete Cooling Plant

Latent heat = 144 BTU/lb

Water Supply Temperature, say 65°F

reduced to 32°F = 33 BTU/lb

177 BTU/lb ice

177 Btu/lb x 120 lb ice/CY = 21,200 Btu/CY

$\frac{21,200 \text{ Btu/CY} \times 40 \text{ CY/Hr}}{12,000 \text{ Btu/Hr/Ton}}$ = 71 Tons

Conventional machine on Freon 12 (15° - 105°) = 1.54 Hp/Ton

$\frac{109 \text{ HP} \times 0.746 \text{ KWH/HPH}}{40 \text{ CY/Hr} \times 0.80 \text{ P.F.} \times 0.80 \text{ eff}}$ = 3.18 KWH/CY

Assume a rate of $0.0128

$0.0128 x 3.18 KWH/CY = $0.041

SAY $0.04/CY