Analysis 3
Alternative Grade Beam Placement Method

Background

      The general contractor originally proposed that all grade beams be excavated and formed using stick built forms. After concrete placement, the forms were to be stripped and the grade beams were to be backfilled. This method requires more labor and material cost for excavation and added costs and schedule time for formwork. An excavated trench for a grade beam to be formed in can be seen in the photo to the right.

Goal

      The goal of this analysis is to determine if placing concrete into excavated trenches can significantly reduce schedule time, labor, and material costs. The proposed placement method eliminates the need for formwork and decreases the volume of excavation. It is important to note that although very little excavated material will be hauled off site, this method could reduce the need for backfill when formwork is stripped.

Methods
- Concrete Quantity Take-Off
  - Determine the quantity of concrete in Cubic Yards
  - Apply waste factor for waste concrete
- Estimate Formwork Savings
  - Labor & Material
- Calculate Schedule Reduction

Resources
- Holder Construction Company
- R.S. Means Cost Works 2005

Results

      Upon completing this analysis, it can be determined that placing concrete into excavated trenches is a more efficient method. Although there is minimal impact on the excavation costs, the schedule and formwork savings are significant. The cost, schedule, & material analyses can be seen in detail in the following sections.

Cost Analysis

To complete this analysis, soil excavation and concrete quantities had to be determined using the structural foundation plans and values obtained from the General Contractor, Holder Construction Company. Actual widths of excavation for formed grade beams were obtained from Holder Construction Company. A detailed quantity take-off of concrete material and proposed soil excavation were carried out. Excavation quantities were calculated using a depth from grade (30'-6") to bottom of grade beam elevation. Formwork quantities were calculated from the structural foundation plans using total contact area of formwork.

The expected outcome of a reduction in formwork costs and slight increase in concrete material costs were confirmed. As can be seen below in Table 4-Grade Beam Cost Comparison, the proposed placement method introduces a savings of approximately 64% to the foundation budget. Due to little to no excavated material being hauled off site there is very little impact to excavation costs. A 15% waste factor was applied to the concrete quantities due to placing concrete directly into trenches. Labor and Material Savings for eliminated formwork far out weigh the additional cost of concrete. Depending on trench location, concrete placement will still be directly out of chute or from concrete pump. A detailed copy of the of the material cost estimate can be found on the following two pages in Tables 5-8.

Overal Cost Comparision		
	Formed Grade Beams	**Excavated Trenches**
Formwork	$81,274.58	-
Concrete	$36,800.00	$42,550.00
Excavation	$4,416.03	$1,681.30
Total Cost	**$122,490.61**	**$44,231.30**

Table 4- Grade Beam Cost Comparison

Concrete Cost Impact						
Grade Beam	Width (ft.)	Length (ft.)	Depth (ft)	CY	Unit Price ($/CY)	Total Cost ($)
1' W x 2' D	1	10	2	1	$115.00	$85.19
1.5' W x 2' D	1.5	525.83	2	58	$115.00	$6,718.94
1.5' W x 2.5' D	1.5	104.09	2.5	14	$115.00	$1,662.55
2' W x 2' D	2	353.84	2	52	$115.00	$6,028.39
2' W x 2.5' D	2	583.25	2.5	108	$115.00	$12,421.06
2' W x 3' D	2	118	3	26	$115.00	$3,015.56
2' W x 3'-6" D	2	61	3.5	16	$115.00	$1,818.70
2'-2" W x 2' D	2.17	30	2	5	$115.00	$554.56
2'-2" W x 3' D	2.17	72	2	12	$115.00	$1,330.93
3' W x 2' D	3	94.67	2	21	$115.00	$2,419.34
3'-6" W x 2' D	3.5	14	2	4	$115.00	$417.41
3'-8"x2'	3.67	10.67	2	3	$115.00	$333.58

Original Cubic Yards		320
Original Total Cost		**$36,800.00**
15% Waste Factor Increase		48
Total Cubic Yards		368
Increased Cost ($115/CY)		**$5,635.00**
Total Cost		**$42,550.00**

Table 5- Concrete Cost Impact

∗ 15% Waste factor assumed for placing concrete directly into excavated trenches
∗∗ Concrete Unit prices obtained from Holder Construction Company. Excluding reinforcing cost

Formwork Material Savings					
Grade Beam	Length (ft.)	Depth (ft)	Contact Area (SF)	Unit Price ($/SF)	Total Material ($/SF)
1' W x 2' D	10	2	40	$7.00	$280.00
1.5' W x 2' D	525.83	2	2103.32	$7.00	$14,723.24
1.5' W x 2.5' D	104.09	2.5	520.45	$7.00	$3,643.15
2' W x 2' D	353.84	2	1415.36	$7.00	$9,907.52
2' W x 2.5' D	583.25	2.5	2916.25	$7.00	$20,413.75
2' W x 3' D	118	3	708	$7.00	$4,956.00
2' W x 3'-6" D	61	3.5	427	$7.00	$2,989.00
2'-2" W x 2' D	30	2	120	$7.00	$840.00
2'-2" W x 3' D	72	2	288	$7.00	$2,016.00
3' W x 2' D	94.67	2	378.68	$7.00	$2,650.76
3'-6" W x 2' D	14	2	56	$7.00	$392.00
3'-8"x2'	10.67	2	42.68	$7.00	$298.76
Total Contact Area (SF)		**9015.74**			
Total Formwork ($)					**$63,110.18**

Table 6- Formwork Material Savings

∗ Formwork Unit prices obtained from Holder Construction Company

Labor & Schedule Savings

   The proposed placement method produced labor savings in formwork and excavation of approximately $18,000 and $3,000 respectively. Both excavation and concrete placement can be accelerated by 4 and 15 days respectively. This allows column piers and erection of steel columns to begin earlier. It is noted that the acceleration in excavation schedule could be impacted by reduced productivity due to exact excavations for grade beam trenches needed. The results of the labor and schedule savings can be seen below in Tables 7-10.

Original Excavation						
Grade Beam	Width of Excavation (ft.)	Length (ft.)	Depth to Bottom GBM (ft)	BCY	Labor & Equipment ($/BCY)	Total Cost
1' W x 2' D	5	10	2	4	$5.20	$19.26
1.5' W x 2' D	5	525.83	2	195	$5.20	$1,012.71
1.5' W x 2.5' D	5	104.09	2.5	48	$5.20	$250.59
2' W x 2' D	5	353.84	2	131	$5.20	$681.47
2' W x 2.5' D	5	583.25	2.5	270	$5.20	$1,404.12
2' W x 3' D	5	118	3	66	$5.20	$340.89
2' W x 3'-6" D	5	61	3.5	40	$5.20	$205.59
2'-2" W x 2' D	5.5	30	2	12	$5.20	$63.56
2'-2" W x 3' D	5.5	72	2	29	$5.20	$152.53
3' W x 2' D	6	94.67	2	42	$5.20	$218.79
3'-6" W x 2' D	7	14	2	7	$5.20	$37.75
3'-8"x2'	7	10.67	2	6	$5.20	$28.77
				849	Total Cost	$4,416.03

Table 7- Original Excavation Costs

Proposed Excavation						
Grade Beam	Width of Excavation (ft.)	Length (ft.)	Depth to Bottom GBM (ft)	BCY	Labor & Equipment ($/BCY)	Total Material Cost
1' W x 2' D	1	10	2	1	$5.20	$3.85
1.5' W x 2' D	1.5	525.83	2	58	$5.20	$303.81
1.5' W x 2.5' D	1.5	104.09	2.5	14	$5.20	$75.18
2' W x 2' D	2	353.84	2	52	$5.20	$272.59
2' W x 2.5' D	2	583.25	2.5	108	$5.20	$561.65
2' W x 3' D	2	118	3	26	$5.20	$136.36
2' W x 3'-6" D	2	61	3.5	16	$5.20	$82.24
2'-2" W x 2' D	2.5	30	2	6	$5.20	$28.89
2'-2" W x 3' D	2.5	72	2	13	$5.20	$69.33
3' W x 2' D	3	94.67	2	21	$5.20	$109.40
3'-6" W x 2' D	4	14	2	4	$5.20	$21.57
3'-8"x2'	4	10.67	2	3	$5.20	$16.44
				323	Total Cost	$1,681.30

Table 8- Proposed Excavation Costs

✳✳   Labor and cost data obtained from R.S. Means Cost Works 2005.
    (Labor= $3.58/BCY, Equip.= $1.62/BCY)
✳✳✳ 8 hour work days assumed

Labor Savings			
Labor			
Crew	Unit Price ($/HR)	Duration (Hrs)	Total Cost ($)
1 Foreman	$56.47	120	$6,776.40
4 Carpenters	$53.35	120	$6,402.00
1 Laborer	$41.55	120	$4,986.00
		Total Labor Cost ($)	$18,164.40

Table 9- Labor Savings

Schedule Impact			
Item	**BCY**	**BCY/Day**	**Days**
Formed Grade Beam Excavation	850	150	6
Trench Grade Beam Excavation	323	150	2
		Difference	**4 Days**
Formwork			
Contact Area (SF)	Daily Output (SF/Day)	Schedule Acceleration	
9016	600	**15 Days**	

Table 10- Schedule Impact

* Grade Beam excavation unit prices & formwork labor rates taken from R.S. Means Cost Works 2005

** Formwork schedule durations obtained from Holder Construction Company

*** Formwork crew includes 5 carpenters and 1 Laborer

Conclusion

The major time and material savings found through this analysis make it obvious that an excavated trench method is very feasible and proficient method for foundation concrete placement. It was learned that this placement method is mostly helpful for formwork cost and time savings. A further analysis of this method could look at the space planning and layout issues of using excavated trenches for grade beams. To make this method efficient the trenches must be excavated rather precisely to avoid too much concrete waste. Additionally, quality control/assurance comparisons could be completed for the two methods.