BEFORE THE
MARYLAND STATE BOARD OF CONTRACT APPEALS

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| Appeal of HARDAWAY CONSTRUCTORS, INC. | ) | |
| | ) | Docket No. MSBCA 1249 |
| Under SHA Contract No. AA-169-501-570 | ) | |

November 7, 1989

Differing Site Condition - Type 1 - The Board found that a Type 1 differing site condition existed at the project site (South River Bridge) where test piles reached bearing at elevations that significantly varied from the elevations at which bearing was expected to be reached as represented by the estimated tip elevations set forth in the contract.

Differing Site Condition - Type 2 - The Board found that a Type 2 differing site condition existed given the significant variations in elevations at which piles achieved their bearing capacity within and between piers during both the test pile phase and the production pile phase of the contract work. Such variation in depths of elevation when driving piling in the site area of the South River was unusual and not ordinarily encountered.

Differing Site Condition - Equitable Adjustment - If a contractor's costs of performance increased due to a differing site condition, the contractor is entitled to an equitable adjustment for such costs, however occurring, even if overall contract performance time did not extend beyond the contract time allowed. Performance within the contract period, however, eliminates recovery for contract delay type costs, e.g., extended overhead.

Differing Site Condition - Equitable Adjustment - Where the responsibility for damage is clear the Board does not require that the amount thereof be ascertainable with absolute exactness or mathematical precision. It is enough if the evidence adduced is sufficient to enable the Board to make a fair and reasonable approximation.

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OPINION BY MR. KETCHEN

This timely appeal involves Appellant's appeal of the State Highway Administration's denial of Appellant's differing site conditions and changes claims for an equitable adjustment in the amount of $576,454.16 plus predecision interest.

I. In general, Appellant asserts differing site conditions claims and changes claims with attendant impact costs in the total amount of approximately $890,926.21 predecision interest. Appellant's claim is based on 131 days of

critical and non-critical delay although the contract was completed within the time allowed by the contract. The claims as modified and asserted by Appellant based on its view of the evidentiary record are as follows:

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| a. | Wave Equation Analysis | $ 22,137.73 | 5 Days (40 hrs.) |
| b. | Test Load at Pier 9 | $ 39,244.07 | 22 Days |
| c. | 18" Precast Prestressed Concrete Test Piles | $115,141.78 | 25.5 Days (204 hrs.) |
| d. | 18" Precast Prestressed Concrete Production Piles | $161,593.72 | 44 Days |
| e. | 14" Steel Test Piles (Piers 13 & 14) | $34,237.64 | |
| f. | 14" Steel Production Piles (Piers 13 & 14) | $204,099.22 | |
| | Total Claim (without interest) | $576,454.16 | |

FINDINGS OF FACT

1. In early 1980, SHA solicited and received bids for Contract No. AA-169-501-570, FAP No. BR-F-257-1(5) for the construction a 2,465 foot, four-lane steel beam bridge on Route 2 over the South River in Edgewater, Maryland, and for the demolition of an existing two-lane bridge at that site.

2. The Special Provisions of the contract at page 60 described the scope of work for the project in part as follows:

1. The construction of a steel beam bridge with twenty 90'-0" spans, two 130'-0" spans, two 87'-6" spans, one 70'-0" span and a 160'-0" channel span. Clear roadway widths of 36'-0".

2. The construction of approach embankment for the proposed roadway at the bridge site.

3. The construction of utilities are shown on the drawings included in the Contract.

4. The safe and continuous maintenance of vehicular traffic on Maryland Route 2 and on South River Road during the life of the contract.

3. Certain contract provisions pertinent to the issues raised in the instant appeal are attached to this decision as Appendix A.

4. The new South River Bridge replaced an older two-lane span bridge at approximately the same site. Unlike the old bridge, the new bridge does not have a movable center span. Instead, the new bridge was constructed with a center span 160 feet long set 55 feet above the water. Appellant as the contractor was required to demolish the old bridge after the new bridge was

opened to traffic. As viewed by a reasonable prudent contractor, as derived from the testimony of Appellant's expert,[1] Mr. Friets, the contract documents as bid on provided for construction of the new South River Bridge as follows:

Overview

As detailed on the Contract Drawings, the 2,465 foot long South River Bridge includes a total of 25 pile supported piers, numbered from No. 1 on the Steuart Corner (South West) end consecutively through No. 25 on the Annapolis (North East) end. Pier Nos. 1, 24 and 25 are located above the water line (i.e., land or shore piers) and the remaining 22 are located in the river (i.e., water piers). Pier Nos. 13 and 14, which carry the long span over the proposed channel, are founded on 14 inch 89 pound steel piles. The other two piers are founded on 18 inch square prestressed concrete piles. Two exclusive bid items, one for test (indicator) piles and one for production piles, are provided for each type of piling, each on a unit price per linear foot of piling basis. The bid item provided for load testing is common to both types of piling on a unit price per each load test basis. The Bid Quantities for all five of these bid items are consistent with information furnished by the Contract Drawings.

The Contract Drawings include the location and test data for each of 26 boring and drive tests which are roughly evenly spaced along the bridge center line.

The Contract Drawings locate particular permanent piles to be driven first as test (indicator) piles, with certain of these test (indicator) piles to be used for pile load tests. The Specifications provide for payment under both the test (indicator) pile and pile load test bid items.

Due both to the soil characteristics shown by the borings and to the selection of uniform section type piling, both the 14 inch 89 pound steel piles and the 18 inch square prestressed concrete piles would be expected to be essentially end-bearing in nature.

As detailed on the Contract Drawings, top of pile elevations are all under or only slightly above the water surface. The incidence of battered piles is quite high. [2]

The Specifications state that jetting of 14 inch 89 pound steel piles will not be permitted, and that jetting of 18 inch square prestressed concrete piles will be permitted only after

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[1]App. Exh. 1003, Appendix A, Direct Testimony of Neal R. Friets.
[2]Battered piles are driven at an angle as distinquished from plumb piles which are driven straight into the ground.

receipt and approval of the Contractor's proposed methods. The Specifications also require that wave equation analyses be submitted prior to any driving.

## Test Piles

Bid Item No. 404 is provided exclusively for 14 inch 89 pound steel test (indicator) piles and Bid Item No. 408 is provided exclusively for 18 inch square prestressed concrete test (indicator) piles. The Bid Quantity of 450 linear feet for 14 inch 89 pound steel test (indicator) piles is consistent with the Contract Drawings which specifically locate three steel test (indicator) piles each at Pier Nos. 13 and 14, with one of these test (indicator) piles at each pier shown to be used for load testing as well; it is apparent that the Estimated Pile Tip Elevations established on the Contract Drawings were used as the basis for determining the Bid Quantity. Similarly, the Bid Quantity of 2,390 linear feet for 18 inch square prestressed concrete test (indicator) piles is consistent with the Contract Drawings which specifically locate two concrete test (indicator) piles at each of 23 piers, with one of these test (indicator) piles at Pier Nos. 9, 15 and 20 to be used for load testing as well; it is apparent that the Estimated Pile Tip Elevations established on the Contract Drawings were used as the basis for determining the Bid Quantity.

The Contract Drawings and the Specifications call for plumb piles to be used for test (indicator) and test loading purposes.

The Specifications provide that measurement for payment of a test (indicator) pile shall be made from the driven tip to a maximum of five feet above the cut-off elevation, except that if used for test loading, the top of the test pile shall be a minimum of five feet above mean high water.

Test piles are commonly called indicator piles, in that they generally determine the length of piles in the immediately adjacent area.

## Pile Load Tests

Bid Item No. 409 is provided for load testing both 14 inch 89 pound steel piles and 18 inch square prestressed concrete piles. The Bid Quantity of five each pile load tests is consistent with the Contract Drawings which specifically call for load testing of one pile each at Pier Nos. 13 and 14 on 14 inch 89 pound steel piles and load testing of one pile each at Pier Nos. 9, 15 and 20 on 18 inch square prestressed concrete piles.

The Contract Drawings note that both the steel and the concrete piles have design capacity of 100 tons at 100% unit stress condition, and state that all piles are to be driven to 120% of the design load equal to 120 tons. The Specifications call for test loadings of 200 tons, which is 200% of the design load.

Pile load tests are commonly considered the most reliable check on the applicability of pile driving formulae to determine the acceptability of driven piles, that is, the actual load-carrying capability of piles as driven.

Production Piling

Bid Item No. 403 is provided exclusively for 14 inch 89 pound steel production piles and Bid Item No. 407 is provided exclusively for 18 inch square prestressed concrete production piles. The Bid Quantity of 12,450 linear feet for 14 inch 89 pound steel production piles is consistent with the Contract Drawings, and it is apparent that the Estimated Pile Tip Elevations established on the Contract Drawings were used as the basis for determining the Bid Quantity. Similarly, the Bid Quantity of 32,515 linear feet for 18 inch square prestressed concrete production piles is consistent with the Contract Drawings, and it is apparent that the Estimated Pile Tip Elevations established on the Contract Drawings were used as the basis for determining the Bid Quantity. The Minimum Pile Tip Elevations established on the Contract Drawings are identical to the Estimated Pile Tip Elevations on 9 of the 25 piers and differ by 3 feet or less on 15 of the 25 piers; on only 7 piers do they vary by more than 5 feet and the maximum indicated difference is 8 feet.

The Contract Drawings call for the tops of all 14 inch 89 pound steel piles to be at Elevation -25, with the plumb piles under Pier No. 13 estimated to be 55 feet long and under Pier No. 14 estimated to be 80 feet long. On this basis, there would be no splices in this Pier No. 13 piling and one splice each in the Pier No. 14 piling, using normal mill lengths; such single splices can routinely be made as an operation prior to putting the pile in the leads.[3] The Specifications state that only one splice per pile is contemplated as permitted on the 14 inch 89 pound steel piling, and that splices will not be measured for separate payment. Using welded splices effectively requires that all splicing be completed prior to the pile being within approximately 25 feet of take-up.[4]

The Contract Drawings call for the tops of all 18 inch square prestressed concrete piles (except those in Pier Nos. 1, 24 and 25) to be at Elevation +1, with the piles for each pier estimated to have the same tip elevation, varying only [from] pier to pier. On this basis, most of this piling would not require any special handling due to long length or heavy [pickup] considerations. The Specifications state that no field splices will be permitted in any pile unless specifically approved in writing, and that no payment will be made for field splices or buildup.

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[3]The lead is a device into which the pile is placed. It holds and guides the pile in the proper direction during pile driving.

[4]"Take-up" is the term used to describe the event that occurs when a pile reaches the desired load bearing capacity.

The Contract Drawings show that approximately one-half of the 14 inch 89 pound steel piles and approximately two-thirds of the 18 inch square prestressed concrete piles are to be battered piles. Though this incidence of battered piles is quite high, it does not present a construction problem if the piling can be driven to or nearly to grade as there will be no interference between pile tops.

The Contract Drawings call for all 18 inch square prestressed concrete piles to be cast with ten each #6 reinforcing bar dowels protruding from the tops a length of approximately 2 feet, with embedment into piles of 7 feet, 6 inches. The associated Note states that if pile cutoff is required, these reinforcing bars will not be cut unless embedment into piles is thus reduced to less than 2 feet. This effectively permits up to a 5 foot, 6 inch pile cutoff without altering the reinforcing bar dowels installed during manufacture of the prestressed concrete piling.

* * *

....The information provided relative to pile driving operations for the South River Bridge piers,....[ provides:]

(1) The contract provides a reasonable number of borings, test (indicator) piles and load tests.

(2) The Bid Quantities are consistent with the Contract Drawings, specifically the Estimated Pile Tip Elevations established on the Contract Drawings.

(3) The Estimated Pile Tip Elevations established on the Contract Drawings show profile correlation in that they generally provide for a few feet of pile penetration into very dense, silty sand with relatively high sampling spoon blows per foot.[5]

(4) The Contract Drawings effectively furnish an estimated length for each pile by virtue of complete Estimated Pile Tip Elevations and dimensions to pile tops from foundation elevations. This estimated length for each pile is the basis for Bid Quantities and is reasonably the basis for estimating the cost of both test (indicator) and production piling, which in turn provide the bidding basis for Project duration.

(5) Test loading piles to 200% of the design load is common, but requiring piles to be driven to 120% of the design load is unusual.

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[5]The sampling spoon blows per foot is a measure of soil resistance obtained from the soil borings taken. Thus the number of blows per foot for the sampling spoon obtained in the soil boring process gives an indication of the soil density at the soil boring location.

(6) The Bidding Documents effectively encourage test (indicator) piles to be provided no more than five feet longer than the corresponding estimated pile lengths, unless they are to be used for load testing.

(7) The Bidding Documents effectively infer and represent that production piles in each pier will be predictable and uniform in driving characteristics and lengths, involving only minor cutoffs in some instances, and it was reasonable to rely on such representation for bid preparation.

(8) It was reasonable to expect that the piling operation could be smoothly sequenced and performed without delays...

(9) The Contractor should not have anticipated major variances between driven pile lengths for individual piers, or piling substantially longer than set forth in the Contract Drawings, or pile removals, or major cutoffs, or repetitive splices; such changes when experienced are very costly, both in terms of direct expense and extension of construction time. Such major cost items are not reasonably included in unit prices, as they are unknown and unexpected at the time of bidding.

(10) Extra work and delays in the piling operation [could] be critical to overall job progress.

* * *

5. The contract requirements for driving the 18" prestressed concrete piles driven at all concrete pile piers were similar to those for the 14" steel piles driven at Piers 13 and 14. However, the specifications did not permit the use of jetting to drive steel piles. (Contract Special Provisions, p. 73). And the specifications required a wave equation analysis to size the pile-hammer system for the concrete piles. Thus the Special Provisions, at page 79 of the contract, for the 18" prestressed concrete piles state:

> The Contractor shall size the complete pile-hammer system by a suitable wave equation analysis for the various subsurface conditions to be encountered on the project in order to prevent over-stressing the piles and submit the analyses to the Engineer prior to any driving.

The specifications, as discussed below, also permitted use of two different empirical pile driving formulas to drive the steel and the concrete piles depending on the pile driving hammers used. (Contract Special Provisions, pp. 73-76, 78-81).

6. Four contractors bid on this project. On March 18, 1980, the SHA opened the bids for the construction of the new steel beam bridge at South River. Hardaway Constructors, Inc. (Appellant) of Columbus, Georgia was the lowest responsive and responsible bidder. It submitted a bid in the amount of $20,022,432.00.

7. Appellant's contract prices for the pile driving were as follows:

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| Item 407—32,515 Linear Feet (LF) of 18 in. square prestressed concrete pile | $25.00/L.F. | $812,475 |
| Item 408—2,340 Linear Feet (LF) of 18 in. square prestressed concrete test pile | $35.00/L.F. | $ 83,650 |
| Item 403—12,450 Linear Feet (LF) of 14 in. Steel HP Bearing Piles (89#) | $30.00/L.F. | $373,500 |
| Item 404—450 Linear Feet L.F. of 14 in. Steel HP Bearing Test Piles (89#) | $35.00/L.F. | $ 15,750 |

Bidders were required to submit bids based on a fixed unit price per linear foot for the four categories of piling. The unit prices included Appellant's price for all materials, equipment, labor, overhead, and profit.

8. On May 13, 1980, SHA issued a notice of award to Appellant. The project's required duration was 595 work days; 465 work days to complete the new bridge and open it to traffic, and 130 work days to remove the existing bridge after the opening of the new bridge. A formal contract between SHA and Appellant was executed on June 11, 1980. The liquidated damages

established by the special provisions of the contract for this project were $700.00 per working day for construction of the new bridge and $250.00 per working day for removal of the existing bridge.

9. According to Appellant's schedule submitted on July 30, 1980, Appellant originally planned to complete the project on October 16, 1982. However, the new bridge was not opened until November 11, 1982, the 483rd work day. No liquidated damages were assessed since Extra Work Orders No. 1 through No. 6, No. 8 and No. 10 granted Appellant an 18 work day extension of time. The demolition of the old bridge was completed on April 6, 1983, 89 work days after the opening of the new bridge. The project was accepted by SHA on May 12, 1983.

10. Appellant begun submitting claims for reimbursement for its cost overruns to the SHA procurement officer beginning in January 1981. Appellant thereafter submitted to the SHA procurement officer in May, 1982 one consolidated large claim that incorporated the several previously submitted claims. In a final procurement officer's decision issued on July 10, 1985, the SHA procurement officer denied Appellant's claims on substantive grounds; that is, based on his decision that Appellant had not shown that it was entitled to an equitable adjustment under a contract remedy granting clause, i.e., the Differing Site Conditions Clause or the Changes Clause. (Rule 4 File, Tab. II, SHA Procurement Officer's Final Decision (July 10, 1985)). Appellant thereafter filed a timely appeal with the Appeals Board.

11. With regard to the driving of the 18" concrete piles, the contract calls for driving approximately 46 concrete test piles and 650 concrete production piles at the pier locations across a stretch of river running from Pier 1 on the south side of the river to Pier 25 on the north side of the river.

12. As summarized from Mr. Friets' testimony, set forth above, the plans and specifications specified estimated tip elevations for each pier. In general terms, the estimated tip elevation is the approximate or estimated elevation below the ground surface at which piles should reach their intended design bearing capacity. These estimated tip elevations as set forth in the contract plans represent the bridge designer's projection based on the bridge design and on the soil borings taken and analyzed at each pier of the approximate depth at which the pier piles would be driven before they would take-up. The estimated tip elevations for each pier, as set forth in the contract plans, are the basis on which bidders, including Appellant, determined their bid prices. They necessarily used the estimated tip elevations and number of piles required at each pier to determine the length of piling necessary and the length of each individual pile at each pier. When the length of pile for each pier (i.e., the linear feet from the specified cutoff elevation of +1 foot above mean low water for concrete piles to the specified estimated tip elevation times the number of piles required) is totaled for all piers, the amount determined represents the total linear feet of piling required to support the bridge structure, at least in the designer's view as set forth in the contract documents.

13. In the same manner, Appellant determined the length of the indicator (test) piles for the required test driving program at each concrete pier pile. The contract required the contractor to drive two test piles at each pier location requiring prestressed concrete piles.

14. The contract plans and specifications also provided a minimum tip elevation for each pier. The minimum tip elevation is the mandatory depth penetration requirements for each pile at each pier. In other words, Appel-

lant had to drive each pile past the depth represented on the plans by the minimum tip elevation shown even though the pile may have reached the requisite bearing prior to reaching the specified minimum tip elevation.

15. As stated, the two test piles driven at each pier that required 18" x 18" prestressed concrete piles (we also refer to these piles as 18" prestressed concrete piles) were the means under the contract by which Appellant determined the actual length of each production pile required to be driven and from this length the total amount of production piling that Appellant had to order from the manufacturer as being probably required at each pier. Test piles which achieved a satisfactory bearing were paid for under the contract as test piles but were kept in place and used as production piles while test piles which failed to achieve bearing were withdrawn or abandoned, and under the terms of the contract were not to be paid for.

16. As indicated, production piles of the appropriate length were ordered for each pier based on the results of the test pile program. The depth at which bearing was achieved by the test piles indicated the approximate depth at which production piles should reach bearing. By multiplying the number of piles required for a pier by the length of pile necessary as indicated by the test piles, Appellant could determine the total amount of production piling to order from the manufacturer for that pier. As many as 34 production piles of appropriate lengths per pier for the piers requiring 18" prestressed concrete piles were then ordered from the manufacturer based on the elevations at which the test piles for each pier reached bearing. Note, however, that the two test piles required at each pier were driven at two different locations toward either end of each pier. The concrete piers were as much as 80 feet

wide measured from an end pile location at one end to an end pile location at the other. Piers 13 and 14 where steel test piles were driven were approximately 115 feet wide.

17. In determining the lengths of test piles to be driven for the test pile program conducted at each pier location, Appellant at the time of bidding, when it determined the unit prices it would offer, relied on the estimated tip elevations set forth on the contract plans and added a five foot "cushion". That is, it accounted for this extra five feet in its bid. The contract plans indicated that pile lengths (quantities) should be bid and ordered on the basis of 5 feet above the cutoff elevation of +1 foot. This meant that Appellant based its bid on an additional 10 foot length of pile above the one foot cutoff elevation that it estimated could be required to perform the contract work. Thus, under the contract unit prices that Appellant bid, the unit price per linear foot of pile driven included some of Appellant's costs that it had anticipated from having to drive an extra ten feet for each pile driven. The described method of measurement for payment on a unit price basis is also the method used for measurement and payment for driving the 14" steel H piles at Piers 13 and 14.

18. Before beginning its test pile program for the concrete pile piers, Appellant was required to perform a wave equation analysis. A wave equation analysis is based on statistical models developed by structural engineers and insures that the pile hammer and pile hammer driving system, including associated equipment, selected to drive the piles does not over-stress, or weaken, or break the piles during driving. A pile driving hammer properly sized based on a wave equation analysis also helps to assure that the piles are accurately driven to specified load bearing capacities based on the empirical pile driving formulas used.

Appellant engaged the services of an expert in civil engineering construction, Dr. T. J. Hirsh, to conduct the required wave equation analysis. Appellant subsequently submitted the results of Dr. Hirsh's analysis to SHA pursuant to the contract's requirements, although Appellant maintains that the contract did not require SHA to review and approve Appellant's wave equation analysis before Appellant could proceed with driving the bridge piling. SHA informed Appellant that SHA would not accept and pay for any test pile driven to bearing until the wave equation analysis and pile driving hammer equipment had been approved by SHA. Pending SHA approval of Appellant's wave equation analysis, SHA would not permit Appellant to drive piling to elevations greater than -75'.

19. SHA rejected Appellant's first wave equation analysis. Appellant submitted a second, revised wave equation on October 11, 1980 which was approved on October 16, 1980.

20. Appellant planned to drive test piles starting from the south side of the river at Pier 3 and to proceed north to Pier 9, where it was to conduct the first static or live load test on a prestressed concrete pile. As set forth the contract required Appellant to conduct a load test on piles driven at designated locations at Piers 9, 15, and 20 before ordering production or permanent piling. A load test involves placing an actual load (here 200 tons) on the pile. The load applied is equivalent to the design load capacity of the pile with the pile to be tested driven in accordance with specified parameters, i.e., according to the specified empirical pile driving formula. The purpose of the load test is to verify that the pile driving formula used to drive the piles will result in piles that achieve the design bearing capacity set forth in the contract and thus provide driven piles that are capable of

carrying the specified design load for the bridge. Appellant planned to order the production piles for these piers, Piers 3-9, on the basis of the results of the load test at Pier 9.

21. When Appellant submitted its intended pile driving procedure, it requested permission to use the Standard Engineering New Record Formula (SEN Formula) for driving the piles with an appropriately sized hammer. The SEN Formula is set forth in Appendix A of this Decision. A pile driving formula is an empirical formula used to aid in selecting a pile hammer and as a guideline for the bridge builder to determine the depth at which a pile will attain the specified load bearing capacity, as indicated by the blowcount applied to the pile. The blowcount for a pile being driven is the number of blows it takes to drive a pile through one foot of material and is a function of the size, speed, and energy generated by the pile driving hammer.

22. In this bridge building project, the contract special provisions specified the Modified Engineering News Record Formula (MEN Formula) for driving the 18" x 18" prestressed concrete piles as opposed to the Standard Engineering News Record Formula (SEN Formula). The SEN Formula is the standard pile driving formula normally used by the State of Maryland for bridge construction. As indicated above, Appellant encountered difficulties in achieving pile bearing as prescribed by the MEN Formula at the estimated tip elevations indicated in the contract, and requested SHA to allow it to use the SEN Formula instead.

Under the SEN Formula, blowcount requirements do not increase as pile length increases. However, when using the MEN Formula to drive piles, the blowcounts necessary to attain bearing increase with depth, i.e., due to the increasing length and weight of pile. The MEN Formula considers the increasing length of pile. The SEN Formula does not. In other words, the

factors in the MEN Formula dictate that as the pile length increases the required blowcount to achieve bearing will also increase. This will result in greater pile depths to attain the required bearing capacity when using the MEN Formula rather than the SEN Formula other factors being equal.

23. Appellant began its test pile driving program for driving 18" X 18" prestressed concrete piles on September 5, 1980. Appellant soon after encountered difficulties in getting the test piles to achieve bearing at elevations consistent with the estimated tip elevations shown on the contract plans. The test piles were being driven much deeper than the estimated tip elevations without achieving bearing. For example, at Pier 6 Appellant experienced subsurface conditions that were materially and substantially different than what was indicated on the contract plans. The two test piles attained bearing at the - 50 foot elevation, although the contract plans indicated the estimated tip elevation as -35 feet (a 143% increase). At many piers, Appellant drove test piles and achieved the required blowcount establishing the required pile bearing capacity within the anticipated ten foot range of the estimated tip elevation, i.e., within the five feet added by the contract to the cutoff elevation and the five feet Appellant added as a cushion when ordering the test piles.[6] At other piers, however, Appellant found that the length of pile selected based on the contract's estimated tip elevations, even with the extra ten foot cushion, was not long enough and the piles did not reach bearing within approximately ten feet of the estimated tip elevation. When this occurred, Appellant was compelled to make a choice.

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[6] In this decision "bearing" and "blowcount" are used interchangeably to mean the elevation at which a pile reaches the specified bearing load capacity based on the specified empirical pile driving formula. To reiterate, the blowcount represents the number of blows it takes to drive a pile one foot through soil material. Bearing under a particular formula, e.g., the MEN Formula, is reached when the number of blowcounts to the pile attains the number of blowcounts specified by the formula.

It could remove (pull) the test pile and replace it with a longer one that had been designated for another pier, or it could splice a second length of pile onto the first. Neither solution was a good one and both added to the time and costs of construction when compared to having a pile attain bearing at or near the indicated contract elevation for a pile set forth as the estimated tip elevation

24. Splicing is structurally undesirable, although permitted, and involves a significant amount of time to perform. The "remove and replace" option is preferred, although this option creates its own set of problems. Removing a pile involves the use of a crane and a water jet which forces tightly pressurized water alongside the pile ("jetting") in order to loosen and wash away the soil surrounding the pile. Because of this disturbance of the subsurface material, jetting has a potentially deleterious effect on the soil surrounding the area where it is used. Under the terms of the contract, Appellant was not entitled to payment for jetting or for removing a pile. (SHA Standard Specifications §34.05-5 "Basis for Payment"). On the other hand as an expedient, borrowing longer test piles already designated for other piers to replace test piles that had to be removed because they were too short disrupted Appellant's "production line" operation and contributed to a loss of its production efficiency.

25. As Pier 1 was a land pier, Appellant had intended to start driving the two test piles at Pier 3 as its first pier for pile driving work within the river. Pier 2 was located right at the waterline. Beginning with Pier 3, the pier locations were within the river's boundaries so that piles obviously had to be driven into the soil below the water surface. After completing the driving of the test piles at Pier 3, Appellant intended to move to Pier 4 and drive two test piles and so on through Pier 9 in a northerly direction across the

river. Pier 9, as discussed below, is where the contract required Appellant to conduct the first live load on a test pile to confirm the validity of the pile driving formula and driving methods before ordering the concrete production piling from the manufacturer. Because the subsurface conditions proved to be unusual and abnormally erratic, Appellant became uncertain as to what length of test pile to use, although the contract plans expressly indicated the estimated tip elevations at each pier at which Appellant could expect to achieve bearing when driving the test piles. In this regard, as an example of the circumstances that Appellant encountered, Appellant traversed the river from pier to pier in a northerly direction driving test piles. At a pier a test pile would drive to its bearing capacity at a shallower depth than Appellant anticipated from review of the contract plans. This left a test pile, which Appellant had chosen on the basis of the contract's estimated tip elevation, with an excess length of pile sticking out of the water above the cutoff elevation that had to be cutoff. Cutoff of a pile is in itself an expensive procedure. If Appellant had to cutoff piles greater than five feet the cutoff procedure required a concrete saw and jackhammer as well as a crane to hold the heavy piece of piling being cutoff.

26. At Piers 10, 17, 18, and 20, Appellant drove test piles which it had to remove and for which it did not receive compensation. At Piers 6, 8, 9, 11, and 12, Appellant drove test piles 19 feet beyond the estimated tip elevation shown on the plans for these piers. However, because it had selected longer test piles from other test piles it had available and that it had intended to drive at other pier locations, Appellant was able to achieve the requisite blowcount. It thus avoided the circumstance of having to pull these longer test piles because of running short of pile before bearing capacity could be reached.

27. Appellant claims, however, that because it was forced to use test piles in the described fashion its production efficiency was significantly impaired, although it was paid for the complete quantity of pile driven based on the contract unit price for driving test piles. Appellant maintains that borrowing and using test piles it planned to use at other pier locations decreased its efficiency in driving the piling and resulted in increases to its cost above what it was paid based on the specified contract unit price.

28. Because of the shortage of sufficiently long test piles, the test piles having been ordered according to the contract's indicated estimated tip elevations, and because of the concern that jetting to remove piles of a short length that had not reached bearing was damaging the soil, SHA and Appellant agreed at one point during contract performance that Appellant would drive the test piles out of permanent (or production) pile locations; that is, into the soil outside of the boundaries of the pier locations. As noted in this regard, the contract provided that test piles were to be driven in permanent pile locations and subsequently used in the bridge structure as production piles. Appellant was paid at the contract unit price for driving test piles to bearing out of permanent pile locations. It then subsequently removed and reused these piles and again was paid for them on a unit price basis pursuant to the terms of the contract. However, it was not paid for the additional time and cost of removal, for the cost attributable to the additional time required for driving longer test piles than anticipated, or for the impacts due to the interruption to its planned sequence and mode of ordering and driving test piles based on the estimated tip elevations shown on the contract plans and specifications.

29. Appellant's approach of using extra long piles helped minimize the need for the removal of piles or the splicing of piles if piles drove to deeper elevations than anticipated. However, it increased the need for cutoffs of piles to the specified cutoff elevation of +1' above the water line when piles drove short of or near to the bearing elevation indicated by either the contract's estimated tip elevations or the information obtained from the test pile program. In this regard, "a major cutoff" would be one that had to be made prior to the time adjacent piling could be stuck and driven, or would be of such length that a derrick would have to be provided to hold the piling to be cut off or any cutoff that was longer than 10' feet, which would require that all new dowels be provided; that is, holes had to be drilled in the end of the cutoff pile, dowels inserted, and epoxyed. These major cutoffs involved the crane operator and additional crew members and resulted in substantial impact and disruption and additional cost above what should have been expected from normal pile driving operations.

30. Minor cutoffs were designated as cutoffs of up to five feet above the waterline which could be performed by two men and without a crane. In this regard, Appellant was paid for cutoffs on the basis of its contract unit price which should have included cutoff costs as part of its unit price per linear foot of pile for the length of pile that attained bearing, as measured from the tip of the pile up to 5 additional feet above the cutoff elevation of +1' above the waterline.

31. Another problem with driving extra long piles was pile breakage. To alleviate or avoid this problem, Appellant sometimes used a rig to jet start holes. Even at piers where the test pile results were fairly uniform, when driving the production piles Appellant often experienced severely erratic and abnormal driving conditions from one side of the pier location to the other

side. By severely erratic and abnormal driving conditions, we mean driving conditions under which the piles do not drive to relatively uniform depths. They drive well short of, at, or well below the contract's estimated tip elevations for the same pier.

32. As stated, the contract required Appellant to perform three load tests on the concrete piles, one each at Piers 9, 15, and 20. The contract required Appellant to conduct a live load test on a test pile at Pier 9 as a prerequisite to ordering the 18" x 18" prestressed concrete production piles from the pile manufacturer. On September 15, 1980, Appellant, using the MEN Formula, drove a 75 foot pile at Pier 9 to a depth 9.02 feet below the contract estimated tip elevation for Pier 9 without achieving the blowcount required to satisfy the bearing requirements dictated by the MEN Formula. However, the pile reached bearing capacity that exceeded the driving parameters of the SEN Formula, although it was not driven to the parameters of the SEN Formula. Appellant requested SHA to permit it to proceed with the required live load test at Pier 9 despite the low blowcount for the test pile. The blowcount exceeded bearing requirements using the SEN Formula but not the bearing requirements indicated by the MEN Formula. Appellant hoped to show that the pile driven based on actual criteria that exceeded the criteria dictated by the SEN Formula could bear the requisite load. Appellant's technical theory is that if a shorter pile driven based on the SEN Formula was successfully tested with the required live load then this would mean that a longer pile driven based on the more conservative MEN Formula would logically meet the contract's static load test requirements. Appellant, however, misunderstood its discussions with SHA in concluding that SHA

agreed to pay for the load test provided the results were satisfactory, although the pile tested was driven to the SEN Formula instead of the contractually mandated MEN Formula.

34. On September 19, 1980, at a construction progress meeting, SHA denied Appellant's request that SHA permit it to use the SEN Formula instead of the MEN Formula as the basis for the load test on the test pile at Pier 9. SHA informed Appellant that it would not accept the test pile or the test load conducted on the test pile until driven to the blowcount dictated by the MEN Formula as required under the terms of the contract.

35. Appellant had already been setting up the Pier 9 load test on the test pile for a full week. It had already accomplished all of the difficult preparation. Accordingly, it decided to proceed with the load test in spite of SHA's denial of Appellant's requested change to the testing procedure; i.e., the pile tested was driven to parameters that exceeded those of the SEN Formula but did not meet the parameters of the contractually specified MEN Formula.

36. Appellant requested the design engineer of Greiner Engineering to examine the test load set up. The design engineer did so and made several suggestions regarding the conduct of the load test. Appellant adopted the design engineer's suggestions prior to running the Pier 9 load test. Appellant conducted the load test on September 22-24, 1980. The pile successfully carried a live load of twice the contract design load requirements, i.e. 200 tons, although it had not been driven to bearing pursuant to the MEN Formula but had been driven to parameters that exceeded the criteria specified by the SEN Formula.

37. SHA, however, rejected the Pier 9 load test, although the pile successfully carried the required actual load specified by the bridge design. SHA required Appellant to conduct another load test at Pier 4 on a pile driven to the MEN Formula.

38. After successfully completing the test load at Pier 4 on a test pile driven based on the MEN Formula and receiving approval from SHA, on October 6, 1980 Appellant ordered production piles for Piers 3-9, and proceeded with its test pile driving program for the remainder of the concrete pile bridge piers using the MEN Formula.

39. Because of the 75 foot restriction imposed by SHA on the length of piles driven pending completion of SHA's review and approval of the wave equation analysis, Appellant at one point during the initial phases of construction chose to relocate its test pile driving program to the north end of the project to those piers closer to the northern shore of the river where the contract's estimated tip elevations indicated for those piers were less than the -75' elevation restriction. Appellant continued with its test pile program on the north side of the river beginning with Pier 22 and worked toward the middle of the river continuing with the test pile driving at Pier 21 and so on.

Appellant continued to have problems driving piles to the depths indicated by the contract's estimated tip elevations when using the MEN Formula. In this regard, when deciding on the length of production pile to order in situations where the two test piles driven at a given pier yielded divergent results, that is, where a test pile drove to bearing at an elevation at one end of the pier that varied significantly from the bearing elevation of the test pile driven at the other end of the pier, Appellant used the longer length indicated by a test pile as the basis for ordering production pile lengths from

the manufacturer. In addition, at Piers 18, 19, and 20, test pile driving at these adjacent piers gave divergent results. Adjusting to this circumstance, Appellant made conservative adjustments based on the test pile depths achieved and ordered production piles longer than might have been indicated as necessary by the test piles driven at any one of these particular piers. Appellant thus acounted for the possibility that longer piles would be required to reach bearing. Appellant did this in order to insure against the possibility of having piles that were too short that would have to be pulled, abandoned or spliced.

40. Appellant resumed its test pile program on the south side of the river at Pier 10 on October 2, 1980 and continued in sequence with test pile driving at Pier 11, 12, etc. A 70 foot test pile driven by Appellant at Pier 10 using the MEN Formula did not achieve the required blow count, although driven well below the estimated tip elevation indicated on the contract plans. Appellant removed this pile.

41. The contract plans called for installation of steel piles at Piers 13 and 14 which are located on either side of the boat channel in the middle of the South River. The contract required Appellant to drive three test piles and to conduct a live load test on a pile at each one of these piers. Appellant experienced problems achieving bearing with the steel test piles at Piers 13 and 14. The driving problems encountered were similar to those that it had encountered at those piers where it drove the 18" x 18" prestressed concrete piles. A significant variation occurred between the estimated tip elevations indicated in the contract plans at which the 14 test piles were expected to achieve bearing and the elevations at which they actually achieved bearing.

42. As with the 18" x 18" prestressed concrete piles, Appellant initially began driving the 14" steel test piles to the blowcount the MEN Formula indicated as necessary to achieve bearing capacity.

43. It became apparent to Appellant during driving of the 14" steel test piles at Piers 13 and 14 that it was not going to achieve the requisite blow count (bearing capacity) based on the MEN Formula even after in-leads' splices had been performed on piles that continued to drive without attaining bearing. At this point, SHA agreed with Appellant that Appellant should drive a 14" steel test pile to the SEN Formula and load test it.

44. On November 24, 1980, SHA directed Appellant to drive the steel piles using the SEN Formula. However, the contract specifications indicate that the contract required Appellant to drive the steel piles, including the steel test piles, based on the SEN Formula as Appellant was using an underwater hammer, an option available to Appellant under the contract. The contract requires use of the SEN Formula when driving steel bearing piles with this type of hammer.

In this regard, SHA actively and clearly assumed responsibility for contract interpretation regarding the appropriate driving formula to use for the 14" steel piles at Pier Nos. 13 and 14. It directed Appellant in the manner and method of performance of this work. Thus, the SHA procurement officer stated as follows:

> Paragraph 1, Page 75 of the Special Provisions advises:
>
> > With the use of a follower or a long pile extending above the water, the bearing value formulas of Section 34.05-3, Paragraph 7, Determination of Bearing Value will be modified to include the weight of pile to weight of ram ratio.
>
> This formula is commonly referred to as the Modified ENR Formula. From this information, the SHA Project Engineer determined that a long pile did extend above the water and therefore, the Modified ENR Formula was to be used to determine bearing value. Subsequently, the 100 foot length was driven

without achieving required bearing, spliced and driven to elevation -118 without achieving bearing according to this modified formula. It became evident after the pile was driven to -118 that the pile could never achieve the required bearing under the modified formula but could achieve the desired bearing value if the Standard ENR Formula was used. The SHA Project Engineer on Friday afternoon, advised the SHA Design Section and Design Consultant of the results of the pile. The designers advised that the information would be reviewed and since Saturday and Sunday were non-work days, would respond on Monday, November 2, 1980. On Monday, the designer recommended that since the pile driving hammer was in direct contact with the pile during driving, the Standard ENR Formula was appropriate for determining bearing. From Monday until 2:00 p.m. Tuesday, November 3, 1980, discussions occurred between the Project, Design and the Bureau of Construction Inspection to determine the appropriate course of action. At 2:00 p.m. on Tuesday, Mr. Womack, your Project Manager, was advised and agreed with the decision. The SHA Inspector's Daily Reports indicate that contrary to your allegations that a delay occurred, the work crew involved was performing useful, productive work on other items.

As a result of our designer's decision, the bearing value of the test piles were determined with the use of the Standard ENR Formula. Loads test verified that the Standard ENR Formula provided the criteria suitable for establishing accurate bearing. The eight piles that were driven as test piles were subsequently measured and accepted for payment by the Engineer and paid under the pertinent contract item. (Underscoring added.)

(Rule 4 File, Tab II, Administrator's Final Decision, pp. 8-9).

45. SHA concedes that there was a differing site condition at Pier 14. The test piles driven indicated that a "shelf" existed on one side of the pier and not on the other. SHA agrees that this material variation in strata across the Pier 14 location was not indicated in the plans and specifications.

46. When Appellant began its 14" steel production pile driving operation in February, 1981 at Pier 13, many of the steel piles drove to bearing at elevations that were shallower than the elevations that the test piles indicated that they would drive to in order to achieve their specified bearing capacity. Appellant was required to execute cutoffs of these steel piles. Other steel piles driven at Pier 13 failed to achieve the required blow count (bearing capacity) at the point in the driving process when the end of the pile

was still above the water surface. At this time a decision had to be made concerning whether to splice additional steel piling onto the pile being driven before continuing to drive the pile to the -25' cutoff elevation.[7] In those situations, if the decision was made to continue driving without splicing, the pile had to be abandoned if bearing was not attained by the time the pile head was driven to the -25' cutoff elevation.

Thus if the piles were too short such that they did not achieve bearing at the point driving had to stop below the water level, i.e., at an elevation of -25', then Appellant had to pull the pile being driven out of the ground (i.e., the river bottom) and start again and drive a longer pile. It also had the option of abandoning the pile but under the terms of the contract was not to receive payment for abandoned piles.

Alternatively, as just mentioned Appellant could stop driving and splice an additional length of pile onto the pile being driven before the water surface was reached. However, splicing of an additional length of pile onto a pile being driven is also time consuming, costly, and can be a gamble. A length of pile could be spliced onto the pile being driven only to have the pile reach bearing a few feet later. If that occurred the extra length of pile sticking out of the water would then have to be cut off, although additional piling had just been spliced onto the pile anticipating that a significant additional length of piling would be necessary before actual bearing capacity would be achieved. These additional construction procedures impacted Appellant's operations by adding time and increased costs above the contract costs estimated at the time of contract formation based on the contract's estimated tip elevations.

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[7] The cutoff elevation for the 14" piles driven at Piers 13 and 14 was -25' as distinguished from the cutoff elevation of +1' mean low water for the 18" concrete piles driven at the other concrete pile piers.

## DECISION

I. Entitlement

a. Wave Equation Analysis claim: ($22,137.73; 5 Work Days Delay)

**Appellant's claim is denied.**

Appellant submitted its wave equation analysis on the same day that it intended to start driving its test piles. Appellant contends that under the literal terms of the contract all it had to do was submit a wave equation analysis to SHA. It contends that it was then authorized by the contract to proceed to drive the test piles and, based on the results of driving the test piles, to order and drive production piles. Appellant maintains that it was improperly delayed when not permitted to proceed with pile driving untilafter SHA had reviewed and approved Appellant's wave equation analysis.

Appellant's position that it had only to submit a wave equation analysis and not await receipt of its approval before proceeding with construction is unreasonable under an objective view of the contract's terms. SHA clearly had the contractual right to approve the size of the hammer and the thickness of the cushion block used on the hammer based on review and approval of the wave equation analysis which was employed to assure that the pile driving hammer would not damage the piles and that Appellant would drive the piles properly to their bearing capacity. The opposite interpretation that the contract required Appellant only to submit a wave equation analysis to SHA but did not require SHA's review and approval of the wave equation analysis before Appellant could proceed with pile driving would render meaningless the contractual requirement that it do a wave equation analysis in the first place. There would be no purpose in requiring Appel-

lant to submit a wave equation analysis if SHA was not going to use it. Here it was to ensure that the piling important to the support of the bridge structure was properly driven by a properly sized hammer approved by SHA.

Contract clauses are required to be interpreted objectively where possible to give meaning to all contract terms as interpreted by a reasonably intelligent bidder. Intercounty Construction Co., MDOT 1036, 2 MSBCA ¶164 (1987); The Driggs Corp., MSBCA 1235, 2 MSBCA ¶141 (1987) at 14. Accordingly, we give a reasonable and objective interpretation to the contract provision here in issue as requiring Appellant to conduct a wave equation analysis and submit it to SHA for review and approval. The contract terms reasonably required Appellant to submit the wave equation analysis to SHA for review and to obtain SHA's approval of its wave equation analysis and approval of its pile driving hammer prior to proceeding with its pile driving operation.

b. Test Load at Pier 9 (Claim: $39,244.07; 11 Work Days Delay)

**Appellant's claim is denied.**

The contract required Appellant to drive a test pile at a specified location at Pier 9 to a depth indicated by the MEN Formula and to subject this pile to an actual physical load of twice the design load in order to determine the validity of this empirical pile driving formula. Appellant drove a pile at the Pier 9 location indicated for the pile to be test loaded. The depth to which Appellant drove the pile, however, was not the depth at which load bearing was indicated by the MEN Formula. In the jargon, the pile was not driven to the blowcount dictated by the MEN Formula. However, this pile was driven to bearing capacity at a lower blowcount that was near a blowcount for the bearing capacity that would be indicated by

use of the SEN Formula. The blowcount to which this test pile was driven was also consistent with the blowcount indicated by Appellant's wave equation analysis.

Appellant contends that the MEN Formula results in driving piles to unnecessarily deep elevations to attain load bearing capacities for the bearing piles and that the MEN Formula results in overstressing the piles. Assuming, arguendo, the validity of Appellant's point of view, piles driven using the MEN Formula would be expected to attain bearing at greater depths than piles driven using the SEN Formula due to the increasing depth required to reach bearing under the MEN Formula as pile length and weight of the piles increases. In this regard, a related benefit of the wave equation analysis used to size the pile driving hammer and to determine the thickness of the pile driving cushion is that the wave equation analysis can also be used to indicate elevations at which the load bearing capacity (blowcounts) specified for each pile will be reached. In this case, the blowcounts for the elevations at which load bearing capacity were expected to be reached as generated by Appellant's wave equation analysis, were compatible with, although not identical to, the blowcounts indicated by the SEN Formula for the soil at the South River Bridge location.

Based on these considerations, Appellant requested SHA to accept and to pay for the load test on the designated test pile at Pier 9 that was driven to bearing at a blowcount that was within the parameters of the SEN Formula as confirmed by Appellant's wave equation analysis, if the static load test conducted on the Pier 9 test pile indicated that it would hold the actual live load required by the design of the bridge. Appellant believed that it had made such a bargain with SHA and proceeded with the test despite the absence of SHA approval or under a possible mistaken belief

that SHA had approved Appellant's proposed modification to the contract and to Appellant's pile driving and load test method. Appellant had requested that it be allowed to proceed with this alternative procedure based on the SEN Formula subject to the caveat that it was proceeding at its own risk meaning that it would get paid for the expense of the load test if the test pile sustained the contract required design load under the test. Appellant's understanding was that it would not be paid if the pile failed to carry the contractally specified test load.

SHA, of course, disagrees. SHA maintains that it did not agree to the modification to the contract to pay Appellant for the load test at Pier 9 even if the pile tested sustained the required design static load under the contract's load test requirements because the pile was not driven to the MEN Formula as the contract required.

The circumstances existing during this period of contract performance need some elaboration. At the South River Bridge construction site Appellant's pile driving operation clearly was disrupted. There was no consistency in the depths to which the piles were being driven using the MEN Formula. Appellant was not achieving its hoped for "production line" construction sequence as far as the test pile driving aspect of the contract was concerned. Appellant hoped to relieve its problems by getting SHA to change the requirements of the contract based on the load test at Pier 9 and to allow it to use the SEN Formula as verified by its wave equation analysis in order to establish elevations at which pile design load bearing capacity would be achieved when driving the concrete piles.

Turning back to the Pier 9 pile load test, the particular pile tested by actual live loading of the test pile to 200 tons (i.e., to 200% of the design load of 100 tons) at Pier 9 met the design load requirements for an actual

load as required by the contract. However, as stated above, SHA would not pay for the cost of the load test for this pile since it was not driven to the blowcount (bearing capacity) specified by the MEN Formula as required by the contract. Nor was it driven to bearing specified by the SEN Formula. Rather it was driven to bearing at a blowcount falling somewhere between the blowcounts specified by the SEN Formula and the blowcounts specified by the MEN Formula.

SHA is not responsible for this cost. SHA directly informed Appellant that it would not approve or pay for Appellant's load test on the Pier 9 test pile unless driven to the parameters of the MEN Formula as required by the terms of the contract. The contract required the actual loading of a pile to give a benchmark (or to test) for use of the contractually required MEN Formula. Driving a pile to a different formula - not required by the contract - and then load testing did not meet the contract's requirements. The fact that the pile that was tested with an actual live load and met the design requirements for a load to be carried by an individual pile is meaningless if the parameter sought to be tested was the validity of the MEN Formula for use in driving the 18" prestressed concrete piles at the bridge pier locations.

Appellant argues that it is entitled to payment because the successful load test on a pile driven to SEN Formula requirements logically met the load test requirement for a pile driven based on the requirements of the more conservative MEN Formula. However, SHA was reluctant to approve use of the SEN Formula for safety reasons. SHA was not sure that the bridge load bearing piles driven to bearing using the SEN Formula criteria, which it had not analyzed in designing the bridge, would give the bridge the load bearing capacity SHA wanted to achieve and set forth in the contrac-

tually specified design based on use of the MEN Formula. SHA had the right to insist on what it bargained for under the contract's terms. Accordingly, this claim is denied. Appellant thus is not entitled to payment for the load test on the 18" prestressed concrete pile at Pier 9 since it was not conducted in accordance with the contract's requirements.

c. Pile Driving Claims

(a) 18" Prestressed Concrete Test Piles (Claim $115,141.78; 30 work days)

(b) 18" Prestressed Concrete Production Piles (Claim $161,593.72; 44 work days)

(c) 14" Steel Test Piles (Claim $34,237.64; 10 work days)

(d) 14" Steel Production Piles (Claim $204,099.22; 35 work days)

**Appellant's claims are sustained.**

The contract indicated to Appellant what it could reasonably expect about the subsurface conditions. However, actual conditions materially and significantly varied from those indicated. A differing site condition occurred at the site within the meaning of the Differing Site Conditions Clause, thus entitling Appellant to additional compensation as an equitable adjustment for any increased performance costs caused by the differing site condition.

The contract's Differing Site Conditions Clause provides as follows:

> 104.04 DIFFERING SITE CONDITIONS
>
> 104.04.01 The Contractor shall promptly, and before such conditions are disturbed, notify the Engineer in writing of:
>
> (a) subsurface or latent physical conditions at the site differing materially from those indicated in this Contract.
>
> (b) unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and

The Engineer shall promptly investigate the conditions; and if he finds that such conditions do materially so differ and cause an increase or decrease in the Contractor's cost of, or the time required for, performance of any part of the work under this Contract, whether or not changed as a result of such conditions, an equitable adjustment shall be made and the Contract modified in writing accordingly.

104.04.02 No claim of the Contractor under this clause shall be allowed unless the Contractor has given the notice required in 104.04.01 above, provided, however, the time prescribed therefore may be extended by the Administration.

140.04.03 No claim by the Contractor for an equitable adjustment hereunder shall be allowed if asserted after final payment under this Contract.

(Contract p. 169).

We also sustain Appellant's claim phrased in the alternative as a changes claim. The contract Changes Clause provides as follows:

104.05 CHANGES

104.05.01 The Engineer may, at any time, without notice to the Sureties, by written order designated or indicated to be a Change Order, make any change in the work within the general scope of the Contract, including but not limited to changes:

(a) in the Specifications (including drawings and designs);

(b) in the method or manner of performance of the work;

(c) in the Administration-furnished facilities, equipment, materials, services or site; or

(d) directing acceleration in the performance of the work.

104.05.02 Any other written order or an oral order (which terms as used in this paragraph shall include direction, instruction, interpretation or determination) from the Engineer, which causes any such change, shall be treated as a Change Order under this clause, provided that the Contractor gives the Engineer written notice stating the date, circumstances and source of the order and that the Contractor regards the order as a Change Order.

104.05.03 Except as herein provided, no order, statement or conduct of the Engineer shall be treated as a change under this clause or entitle the Contractor to an equitable adjustment hereunder.

104.05.04 If any change under this clause causes an increase or decrease in the Contractor's cost of, or the time required for the performance of any part of the work under this Contract, whether or not changed by any order, an equitable adjustment shall be made and the Contract modified in writing accordingly, provided, however, that except for claims based on defective specifications, no claim for any change under 104.05.02 above shall be allowed for any costs incurred more than 20 days before the Contractor gives written notice as therein required; and provided further, that in the case of defective specifications for which the Department or Administration is responsible, the equitable adjustment shall include any increased cost reasonably incurred by the Contractor in attempting to comply with such defective specifications.

104.05.05 If the Contractor intends to assert a claim for an equitable adjustment under this clause, he must, within 30 days after receipt of a written Change Order under 104.05.01 above or the furnishing of a written notice under 104.05.02 above, submit to the Engineer a written statement setting forth the general nature and monetary extent of such claim, unless this period is extended by the Administration. The statement of claim hereunder may be included in the notice under 104.05.02 above.

104.05.06 No claim by the Contractor for an equitable adjustmenthereunder shall be allowed if asserted after final payment under this Contract.

(Contract, p. 169).

SHA admits that there was a differing site condition at some but not all of the piers. SHA's claims analysis expert conceded that subsurface conditions materially varying from those shown in the contract plans existed at various pier subsurface locations for the piers that were to be supported by 18" X 18" prestressed concrete piles and at Pier 14 that was to be supported by 14 inch (14" X 89) steel "H" piles (Pier 14). (Resp. Exh. 355). SHA concedes that Appellant is entitled to approximately $125,000 as an equitable adjustment for a differing site condition, if the Appeals Board concludes that a differing site condition occurred or if there was a change to the contract work.

One point of divergence between Appellant and SHA, however, is based on SHA's definition of a differing site condition at this site. SHA's view of the differing site condition obviously limits its monetary exposure.

SHA maintains that it is only liable for an equitable adjustment to the extent that the elevations at which the production piles reached bearing varied materially from the elevations at which the test piles driven achieved bearing. SHA thus contends that the elevations at which the test piles attained bearing at each pier under the contract's test pile driving program is the benchmark for measuring a significant variation from conditions represented in the contract, i.e., a Type 1 Differing Site Condition, or a material variation from conditions ordinarily expected, a Type 2 Differing Site Condition, both of which are defined by the contract's Differing Site Conditions Clause. SHA contends that a Type 1 differing site condition did not occur until production pile elevations that were attained differed materially from the elevations at which bearing capacity was attained by the test piles driven at each pier. Thus, SHA maintains that Appellant is entitled to an equitable adjustment under the Differing Site Conditions Clause only to the extent of a material variation between the elevations at which the test piles at each pier location achieved bearing capacity and the elevations at which the production piles achieved bearing capacity.

Consistent with this position, SHA contends that the Board should disregard the contract's estimated tip elevations in determining whether a Type 1 differing site condition occurred although the estimated tip elevations were used by Appellant to bid and by SHA to evaluate the bids when awarding the contract. SHA believes that the contract estimated tip elevations became irrelevant once the test piles were driven at each pier. SHA supports its argument in part based on the fact that the contract is a unit price con-

tract. The contract provides for payment based on a unit price per foot of pile driven. It also contains a Variation in Estimated Quantities Clause which SHA maintains limits payments for overruns or underruns in quantities to the unit prices bid for each type of pile being driven, unless the quantities encountered vary by plus or minus 25% above or below the quantities estimated at the time of bidding.

Appellant, on the other hand, maintains that there was a Type 1 and Type 2 differing site condition, or a change to the contract work. Appellant contends that it determined its bid based on the estimated cost of the work required to drive the length of piling indicated by the estimated tip elevations set forth in contract plans and specifications, although its bid was offered in the form of unit prices as required by the contract solicitation. The contract's estimated tip elevation at each pier indicated the approximate elevations at which the test and production piles were expected to reach their load bearing capacity for the existing subsurface conditions.[8] Appellant thus maintains that the contract plans and specifications indicated the total

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[8] As applicable to the issues raised in this appeal, there are several terms and definitions that involve the term "bearing". These are:

> **bearing capacity:** The maximum unit pressure which a soil or other material will withstand without failure or without settlement to an amount detrimental to the integrity or the function of the structure.
>
> **bearing pile:** A pile which carries weight, as distinguished from a sheet pile which takes earth pressure or a raker which takes thrust. It may be a friction pile or an end-bearing pile.
>
> **bearing plate:** A plate that provides support for a structural member.
>
> **bearing pressure (bearing stress):** The load on a bearing surface divided by its area.

"Construction Dictionary", Construction Terms & Tables, Greater Phoenix, Arizona, Chapter #988 of The National Association of Women in Construction.

quantity of piling needed on which bidders were required to base their bids. This total quantity in linear feet was derived by adding each length of pile at each pier location measured from 6 feet above the water surface for the 18" x 18" prestressed concrete piles (+1 foot above the water line, the specified cutoff elevation, plus a contractually specified 5 feet of additional length of pile above the cutoff elevation) to the depths indicated by the estimated tip elevations shown on the contract plans. Appellant therefore contends that the contract plans and specifications expressly represented subsurface site conditions, i.e., that the estimated tip elevations indicated the designer's evaluation of where piles would achieve bearing based on the resistance of the subsurface soil material to the pile being driven in a particular manner in accordance with the contractually specified pile driving formula.

Appellant thus contends that it is entitled to any increased costs for extra work under the Differing Site Conditions Clause or the Changes Clause where the piles driven attained bearing capacity at elevations that significantly or materially varied from the estimated tip elevations shown in the plans and specifications. We agree and we reject SHA's theory that a Type 1 differing site condition may relate to some action that takes place after contract award and performance has begun, i.e., that, as SHA argues, a Type 1 differing site condition would have occurred only if the production piles driven varied significantly from the test piles driven at the same pier.

As Appellant points out, at the time it had to bid for the contract work it did not have available the bearing elevations attained by test piles driven after contract performance began. Appellant correctly argues that all it had to rely on in formulating its bid were representations in the contract plans

regarding the estimated elevations at which the designer indicated that the piles would achieve bearing, i.e., the estimated pile tip elevations, which turned out to be materially inaccurate.

Under the contract's Differing Site Conditions Clause, "a [Type 1] differing site condition claim 'stands or falls upon what is indicted in the contract documents.'" Weeks Dredging & Contracting, Inc. v. United States, 13 Cl. Ct. 193 (1987). Accord United Contractors v. United States, 177 Ct. Cl. 151, 368 F.2d 585 (1966); Foster Construction C.A. v. United States, 193 Ct. Cl. 587, 435 F.2d 873 (1970). Stated another way, a Type 1 differing site condition depends upon what is represented or implied in the contract documents and raises the issue of what the contractor relied on regarding subsurface conditions in bidding on the contract work. Pacific Alaska Contractors, Inc. v. United States, 193 Ct. Cl. 850, 436 F.2d 461 (1971).

We find as a general matter that SHA's position essentially reads the Differing Site Conditions Clause out of the contract. In this regard, we also find that the Differing Site Conditions Clause and the effect of its provisions cannot be limited based on related exculpatory specifications and contract terms that essentially do away with the statutorily mandated Differing Site Conditions Clause that Appellant was entitled to rely on regarding subsurface conditions. See Piombo Corp., Eng. BCA No. 3276, 72-1 BCA ¶9272 (1972); Dunbar & Sullivan Dredging Co., Eng. BCA Nos. 3165, 3166, 3167, 3191, 73-2 BCA ¶10,285 (1973). Cf. Morrison-Knudsen Co., Inc. v. United States, 184 Ct. Cl. 661, 688-689 (1968); Hollerback v. U.S., 233 U.S. 165 (1914). In addition, we construe the standard Differing Site Conditions Clause and the Changes Clause and the related contract specifications regarding pile driving as being in harmony and not conflicting with the other contract clauses, including the contract's Variations in Estimated Quantities Clause. We find

that those clauses do not affect application of the Differing Site Conditions Clause or the Changes Clause under the circumstances involved in this appeal. Morrison-Knudsen Co., Inc. v. United States, supra.

Thus, as we stated, we reject SHA's argument that one may determine whether a Type 1 differing site condition occurred based on actions undertaken after contract award. That is, the driving of the test piles during contract performance is not evaluated against other aspects of contract performance, i.e., the driving of the production piling, in order to determine whether a Type 1 differing site condition occurred. In other words, a Type 1 differing site condition, which is tied to what the contract represents at the time of bidding, could not involve consideration of material variations between the test pile depths attained at each pier and the depths attained by the production piles driven at each pier. We have not found a case involving the owner's liability under a Differing Site Conditions Clause regarding a Type 1 differing site condition which ties liability to a benchmark or action taken while performing part of the contract work subsequent to contract award, e.g., driving of test piles as the benchmark for measuring a Type 1 differing site condition based on later contract performance in the work sequence. Compare Arundel Corp. v. United States, 103 Ct. Cl. 688, cert. denied, 326 U.S. 752 (1845) (1 hurricane occurring after bid opening but prior to contract award that washed away material pay quantities within the site boundaries was not a differing site condition within the meaning of the Differing Site Conditions Clause); John A. Johnson Contracting Corp. v. United States, 132 Ct. Cl. 645, 132 F. Supp. 698 (1955). Premier Electrical Construction Co., FAACAP 66-10, 65-2 BCA ¶5080 (1965); John McShain Inc. v. United States, 179 Ct. Cl. 632, 375 F.2d 829 (1967).

Consistent with the foregoing we have defined a Type 1 differing site condition in the following terms:

> A 'type 1' differing site condition is contingent upon the existence of some contractual indication concerning the subsurface or physical conditions to be expected. The indication need not be express, may be proved by inference or implication, and need only be sufficient to impress or lull a reasonable bidder. Foster Construction Co., et al. v. United States, 193 Ct. Cl. 587, 435 F.2d 873, 881 (1970).

C.J. Langenfelder & Son, Inc., MDOT 1000, 1003, 1006, 1 MSBCA ¶2 (1980) at 34, aff'd Md. Port Administration v. C.J. Langenfelder & Son, Inc., 50 Md. App. 525 (1982). See Fruin-Colnon Corporation and Horn Construction Co., Inc. (A Joint Venture), MDOT 1025, 2 MSBCA ¶165 (1987); American Dredging Co. v. United States, 207 Ct. Cl. 1010 (1975).

One of the tests of whether a Type 1 differing site condition exists is whether indications of subsurface conditions in the contract would reasonably lead a contractor bidding on the work to a certain conclusion about the subsurface conditions. Fruin-Colnon Corp. and Horn Construction Co., supra, at 55, 60; Pacific Alaska Contractors, Inc. v. United States, 193 Ct. Cl. 850, 436 F.2d 461 (1971), Martin G. Imbach, Inc., MDOT 1020, 1 MSBCA ¶52 (1983). In this regard, the Maryland Court of Special Appeals in Raymond International, Inc. v. Baltimore County, 412 A.2d 1296 (Md. Ct. Spec. App. 1980) citing Hollerbach v. United States, 233 U.S. 165 (1914) agrees regarding the reasonableness of a contractor's reliance on representations of subsurface conditions in a construction contract, and stated as follows:

> We think this positive statement of the specifications must be taken as true and binding upon the Government, and that upon it rather than upon the claimants must fall the loss resulting from such mistaken representations...If the Government wished the matter open to independent investigation of the claimants, it might easily have omitted the specification...in its positive assertion of the

> nature of this much work, it made a representation upon which claimants had a right to rely without an investigation to prove its falsity. See United States v. Utah, N. & C. Stage Co., 199 U.S. 414, 424; see also, United States v. Spearin, 248 U.S. 132 (1918), and Christie v. United States, 237 U.S. 234 (1915).

Raymond v. Baltimore Co., supra, at 1301. (Underscoring added).[9]

The contractual representations of the estimated quantities of piling in terms of length of piling, as based on the contractually represented estimated tip elevations, is the basis for determining whether Appellant is reasonably entitled to protection against loss under the contract's Differing Site Conditions Clause because of a Type 1 differing site condition. As Womack v. United States, 389 F.2d 793 (1968) at 801, thus states:

> An estimate as to a material matter in a bidding invitation is an expedient. Ordinarily it is only used where there is a recognized need for guidance to bidders on a particular point but specific information is not reasonably available * * * Intrinsically, the estimate that is made in such circumstances must be the product of such relevant underlying information as is available to the author of the invitation. If the bidder were not entitled to so regard it, its inclusion in the invitation would be surplusage at best or deception at worst. Assuming that the bidder acts reasonably,* he is entitled to rely on Government estimates as representing honest and informed conclusions.* * * (Footnote omitted). (Underscoring added).

See Weeks Dredging & Contracting, Inc. v. United States, 13 Cl. Ct. 1983 (1987) at 228, 235 (subsurface conditions actually encountered differed materially from subsurface conditions indicated in the contract).

The underlying rationale of the Differing Site Conditions Clause is that

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[9] Dravo Corporation v. Commonwealth of Kentucky, 564 S.W. 2d 16, cited by SHA, is inapposite based on the physical circumstances and contractual clauses involved and on the law.

its inclusion in constructions contracts will reduce contingencies that contractors might place in their bids regarding a construction site's subsurface conditions. Thus,

> The Government customarily relies upon the Changed Conditions [Differing Site Conditions] clause to remove unknown risks from competitive bidding and to obtain favorable bid prices stripped of such risk factors. Such a procurement policy benefits the Government by keeping costs down, and benefits bidders by compensating them by formula for overcoming subsurface conditions not anticipated in their bid estimates and suggested neither in available data nor by site investigation.

Stock & Grove, Inc. v. United States, 204 Ct. Cl. 103, 136 (1974). See also Foster Construction Corp. v. United States, 193 Ct. Cl. 586, 613-15, 435 F. 2d 873 (1970); Kaiser Industries Corp. v. United States, 169 Ct. Cl. 310 at 323, 340 F.2d 322 (Ct. Cl. 1965); Morrison-Knudsen Co. v. United States, 184 Ct. Cl. 661 (1968). We recognized this fundamental policy in our decision in Fruin-Colnon Corp. and Horn Construction Corp., supra, at 66:

> "...we are mindful also of the policy behind the 'Differing Site Condition' clause. This policy is intended to reduce bid contingencies by encouraging bidders to rely upon contract indicators of subsurface conditions in preparing bids. If conditions are otherwise, the government grants an equitable adjustment. Under this premise, the government pays for work commensurate with the level of effort required and the contractor neither absorbs a substantial loss nor makes a windfall profit."

However, as SHA suggests, the test pile driving program brings into play the issue of the reasonableness of a contractor's actions to mitigate its damages after contract performance begins when it becomes aware that the actual subsurface conditions vary materially from those indicated in the contract plans.

In this regard, we next briefly discuss the contract's mandated test pile program which was relied on by SHA and the SHA procurement officer to reject Appellant's Type 1 differing site conditions claim. The Maryland Specifications for Materials, Highways, Bridges and Incidental Structures, March 1968, 2nd Ed. ("Blue Book") at page 306 provides in pertinent part, as follows:

> Section 34.05-3 Construction, Placement and Driving methods
>
> * * *
>
> 4. Required or Anticipated Length of Piling.
>
> The depth of penetration of the length of piling for a project or a part of the project will generally be determined by driving test piles. As a design is based upon the assumption of each pile or group of piles being capable of safely and permanently supporting the assumed design load, it is extremely important that the actual safe bearing value of piling is known. As a general rule, subsurface exploration and drive tests will give the designer a clue as to probable length of piles which will allow the required safe bearing value. Also as a general rule the Plans or Special Provisions will indicate certain minimum lengths, penetrations or tip elevations desired. From this information the Contractor shall order and drive the test piling. The actual safe bearing value of the test piling can then be determined by methods subsequently described. Then from the test pile data and behavior, the Contractor shall order the permanent or remainder of the piling required to complete the contract, all of which is subject to the Engineer's approval.
>
> The provisions of the previous paragraph, while applying primarily to the so-called bearing piles, also apply to pile supporting bulkheads, fenders and jetties. Although the methods for testing bulkheads, piles, and sheet piling may differ from bearing piles, acceptable lengths must still usually be calculated from test piles.
>
> While the above is the usual procedure, there will be cases wherein length of piles must be determined without the benefit of test piles, load tests, borings, and other data. This usually involves piles required for emergency or temporary work, as well as piles for falsework, form supports, cofferdams and piles which are driven by the Contractor for his own use in building the project...
>
> * * *

The above specification indicates that the test pile driving process may be intended to take place subsequent to contract award but prior to ordering and driving the production piles. However, a test pile program conducted after performance of the contract work begins as required here does not somehow become a pre-contract representation of subsurface conditions from which a significant variation could be measured. Appellant was the constructor of the bridge not the designer. Thus, with regard to Appellant's claim it is important to keep in mind the distinction between the bridge construction contract Appellant bid on and contracted to build pursuant to its contract unit prices and the bridge it actually built.

It was important to SHA to have the bridge constructed properly. The procedures outlined above (Blue Book, Section 34.05-3, Paragraph 4, page 306) served this goal. However, Appellant is entitled to additional compensation by way of an equitable adjustment if in following those procedures the subsurface physical conditions encountered materially varied from the contract subsurface conditions represented by the contract plans at the time of bidding and if Appellant's costs increased due to this material variation. Here the material variations that occurred between the actual pile tip elevations at which bearing capacity was achieved by the piles at a number of piers and the reasonably expected elevations at which bearing capacity would be achieved as indicated by the contract's estimated tip elevations demonstrate a material variation in subsurface conditions from those represented in the contract and thus constitute a Type 1 differing site condition.

SHA, however, maintains that Appellant is not entitled to additional compensation because the contract's Variation In Estimated Quantities Clause and other similar exculpatory type clauses found in the contract bar such recovery. SHA thus contends that these contract provisions put Appellant on

notice that the estimated tip elevations and quantities of piling derived therefrom were not exact representations of piling needed based on subsurface conditions but were only approximations or estimates of the quantities of piling expected. SHA thus maintains that Appellant could not rely on them. SHA also contends that it has paid Appellant for the extra length of piling driven based on the unit prices set forth in the contract.

State of Maryland construction contracts, although of a fixed priced nature, are often separated into elements, so-called pay items, such that an item of work defined in the contract, which is usually based on the quantity of work to be done, is paid for on a unit price per quantity basis. Bidders supply unit prices in their bids based on their assessment of the cost to perform the work based on the quantity of work indicated by the pay item estimated in the invitation for bids. A variation in the quantity of the bid item above or below the estimated quantity of the item set forth in the contract at the time of award affects the amount the contractor is paid for its performance of the entire contract work.

The Variations in Estimated Quantities Clause thus provides as follows:

> 104.03 VARIATIONS IN ESTIMATED QUANTITIES. Where the quantity of a major pay item as designated in the Proposal in this Contract is an estimated quantity and where the actual quantity of such pay item varies more than 25 percent above or below the estimated quantity stated in this Contract, an equitable adjustment in the Contract price shall be made upon demand of either party. The equitable adjustment shall apply only to that quantity above 125 percent of the estimated quantity or that quantity below 75 percent of the estimated quantity. If the quantity variation is such as to cause an increase in the time necessary for completion, the Engineer shall, upon receipt of a written request for an extension of time, ascertain the facts and make such adjustment for extending the completion date as in his judgment the findings justify.

However, the Differing Site Conditions Clause overrides the Variation in Estimated Quantities Clause or other similar type exculpatory type clauses, if cost impacts incurred because of the subsurface or latent physical conditions

were not reasonably forseeable. Piombo Corp., supra, 72-1 BCA ¶9272. In other words, the Variation in Estimated Quantities Clause in this contract does not diminish Appellant's rights to an equitable adjustment under the contract's Differing Site Conditions Clause for its increased costs caused by differing site condition. The principle seems obvious that,

> A material variation, not reasonably foreseeable, between the quantity of work set forth in the contract and that actually done is a differing site condition within the purview of the Differing Site Conditions clause. Schutt Construction Co. v. United States, 173 Ct. Cl. 836 (1965). Neither the Variation in Estimated Quantities clause nor the Measurement and Payment Clause has any effect on this legal principle when, as in the present case, the cost of doing the work differs significantly from the unit price in the contract.
>
> We have concluded that a category one differing site condition (changed condition) was encountered by the contractor and that the quantity variations clause must be treated as inapplicable if the cost of doing the work differed significantly from the unit prices in the bid.

A.S. Horner, Inc., 79-1 BCA ¶13,561 (1978) citing Continental Drilling Co., 75-2 BCA ¶11,451.

For reasons similar as to those stated in A.S. Horner, Inc., supra, we find that the several exculpatory phrases and clauses spread like booby traps throughout the instant contract, which SHA maintains supposedly warned bidders against reliance on the contract estimated tip elevations in preparing their bids, do not diminish Appellant's right to rely on the Differing Site Conditions Clause to protect it from the impacts of unexpected and unknown, latent subsurface conditions particularly where the contract representations turned out to be materially inaccurate and the actual subsurface conditions encountered could not have been reasonably foreseen. See Kaiser Industries Corp. v. United States, supra, at 323-24; Morrison-Knudson Co., supra, at 685-89.

In addition to its reliance on the contract's Variation in Estimated Quantities Clause, SHA also contends other exculpatory contract provisions eliminate SHA's liability for the unexpected variation in pile bearing elevations from those based on elevations shown in the contract compared to those elevations at which the piles actually reached bearing that we have found constituted a differing site condition entitling Appellant to an equitable adjustment. In this regard, SHA alludes to the following provisions, among others, and argues that when read together they exculpate SHA from responsibility:

* * *

4. Required or Anticipated Length of Piling.

> "The depth of penetration of the length of piling for a project or a part of the project will generally be determined by driving test piles...As a general rule, subsurface exploration and drive tests will give the designer a clue as to probable length of piles which will allow the required safe bearing value. Also as a general rule the Plans or Special Provisions will indicate certain minimum lengths, penetrations or tip elevations desired. From this information, the Contractor shall order and drive the test piling".

[General Provisions, Section 34.05-3, "Construction, Placement and Driving Methods," p. 306.]

* * *

> "Approximate elevations of pile tips shown on the plans have been estimated from boring information, but are not to be considered final. It will be the contractor's responsibility to determine the pile lengths from test piles".

[Contract Special Provisions, Paragraph 1, page 79.]

* * *

> ...Also no payment will be made for piling not accepted as satisfactory by the Engineer, such as not properly driven piles, piles with questionable safe bearing values, piles damaged during driving or piles driven below planned cutoff, nor for the removal of any pile rejected by the Engineer as unsatisfactory.

[General Provisions, Section 34.05-5, "Basis of Payment," p. 316.]

* * *

> Splices will not be measured for payment and compensation, therefore, shall be included in the unit prices bid for Steel Piles.
>
> [Contract Special Provisions, "Method of Measurement and Basis of Payment," p. 77.]

Turning to the two piers that required steel piles as part of the support structure, both SHA's procurement officer and its SHA's claims analysis expert, Mr. Trauner, assert that Appellant is not entitled to compensation relating to the steel piles that were driven at Piers 13 and 14. SHA thus contends as to Piers 13 and 14 as well that Appellant's claim put forth under the Variation In Quantities Clause provides no adjustment in compensation for a "minor bid" item as distinguished from a "major bid item". The distinction between a "major bid item" and a "minor bid item" under the contract, as we understand it, involves a calculation regarding the proportioned bid item price for a single bid item of the contract as compared to the overall contract price. A bid item price below a certain arbitrary percentage of the overall contract price is labeled a "minor bid" item not subject to equitable adjustment under the terms of the contract.

This major-minor bid item provision and the Variation in Quantities Clause, as we held above, is not sufficient to shield SHA from liability we have determined accrues to it under the contract's Differing Site Conditions Clause. This liability is based on the material variation in actual subsurface conditions from those shown in the contract and is based on the material variation in subsurface conditions from those ordinarily encountered at a site such as the South River site.[10] We thus reject SHA's argument based on the

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[10]We generally discuss the issues in this appeal based on a Type 1 condition. However, we find that the subsurface conditions encountered were unknown physical conditions of an unusual nature and differed from those ordinarily encountered - a Type 2 condition. We find both a Type 1 and and Type 2 differing site condition occurred at this site.

exculpatory clauses it points to. Those provisions necessarily assume that the contract would be performed based on the conditions and circumstances under which it was bid and awarded. However, the bridge Appellant built was not the bridge it contracted to build because of the differing site condition it encountered.

Because of this change in physical circumstances, Appellant is entitled to an equitable adjustment notwithstanding those several contract provisions, some of which are alluded to above, that attempt to shift the differing site risk onto Appellant. See Kaiser Industriess Corp. v. United States, supra at 323-24, 340 F. 2d at 329-30; Morrison-Knudsen Co. v. United States, 184 Ct. Cl. 661, 666, 685-86, 397 F. 2d 826, 829, 841-42 (1968); Foster Constr. C.A. v. United States, supra, at 616, and n. 1 at 595. In this regard, we agree that "[c]lauses to whittle down or cut back the [Differing Site Conditions clause], which is prescribed for [State] contracts, are not broadly or sympathetically interpreted". Stock & Grove, Inc., v. United States, supra, at 110. See Womack v. United States, 389 F.2d 793, 801 (1968)("an estimate as to a material matter in a bidding invitation is an expedient...assuming that the bidder acts reasonably, [footnote omitted], he is entitled to rely on Government estimates as representing honest and informed conclusions...").

SHA next argues that it is not liable because the contract's estimated tip elevation shown for each pier only indicated the designer's estimate or approximation at each pier location of the elevation at which the piles would attain bearing capacity. It contends that the contract warned at page 79 of the Special Provisions that the estimated pile tip elevations shown in the contract were only approximations not to be relied on by the Appellant.

Use of words such as "estimate" or "approximation" in a contract specification or representations in the contract that the estimates are not final but only approximations does not shift the risk of a differing site condition to the contractor in the face of the Differing Site Conditions Clause. See Raymond International, Inc. v. Baltimore County, supra. In this regard, use of "estimates" or "approximations" in specifications, as used here, means to the reasonably prudent contractor that the actual physical characteristics encountered should be reasonably near to those physical characteristics represented by the estimates or approximations. When the actual conditions vary materially from those estimated or approximated conditions represented in the contract documents, a differing site condition occurs. See Elliott's Roofing Co. IBCA No. 1330-1-80; 81-2 BCA ¶15,336 (1981). See generally Dayton Construction Co., HUD BCA No. 82-746-C34 83-2 BCA ¶16,809 (1983) (approximately is an affirmative representation of a quantity.)

However, we need not entirely disregard those exculpatory clauses proffered by SHA. Rather, we read them as being in harmony with the Differing Site Conditions Clause. Thus, these other clauses directed Appellant to expect reasonable variations in the actual tip elevations encountered from the estimated tip elevations shown in the contract which could result in a reasonable variation in quantities of piling needed from that set forth in the contract at the time of bidding. And reasonable variations in terms of length and number of piles in quantities were covered by the contract's Variation In Estimated Quantities Clause. Thus presumably forewarned by the Variation In Estimated Quantities Clause and the several other exculpatory clauses in the contract that attempt to shift any responsibility for what was shown in the contract plans, Appellant added a contingency to its bid. As a safety factor it included in its bid an additional five feet of pile length for each pile

ordered over what the contract indicated would be required. The contract already included a five foot length of pile as a margin for making cutoffs above the +1 foot elevation above mean low water. Thus Appellant's bid was based on a 10 foot cushion per each pile beyond the estimated pile length (measured from estimated tip elevation to the +1 foot cutoff elevation).

We next turn to discuss the facts pertinent to of this appeal. Generally, the indications and representations in the contract plans and specifications reasonably should have led the bidders, including Appellant, to conclude that if they received the award they would drive approximately 34,905 lineal feet of 18" x 18" prestressed concrete test and production piles or about 6.6 miles of this type of piling. Instead, Appellant drove or used (including piling that drove to bearing at elevations shallower than anticipated and had to be cutoff) approximately 42,432.3 linear feet of 18" x 18" prestressed concrete test and production piling, or about 8 miles of concrete piling. Appellant thus used about 2 miles or approximately 121% more 18" x 18" prestressed concrete piling than indicated in the contract plans and specifications.

Similarly, based on an examination of the contract plans and specifications, including the estimated quantities set forth in the contract bid documents as represented by the contract estimated tip elevations, Appellant reasonably should have expected to drive or use 12,900 linear feet of 14" (14 x 89 HP) steel piling at Piers 13 and 14. However, it drove or used 18,580 linear feet of 14" steel piling, which is a 144% increase in actual quantity over the estimated quantity.

We next discuss the contract requirements regarding how the piles were to be driven. The contract plans specified the minimum depths to which Appellant had to drive the piles. This depth was indicated in the contract

plans by a "minimum tip elevation" for each pier location. The contract describes the "minimum tip elevation" for the 18" x 18" prestressed concrete piles in the following terms:

> All piles shall be driven to the minimum safe bearing value shown on the Plans and must penetrate to the minimum tip elevations shown on the Plans or as otherwise indicated by the results [of the test piles and] of the pile load tests, all as directed by the Engineer. The Engineer shall be the sole judge as to what constitutes a satisfactory penetration of the pile into original ground.[11]

(Contract Special Provisions (Special Provisions For Construction of Steel Beam Bridge On Maryland Route 2 Over South River) page 79).

While the contract specified the minimum depths designated by "minimum tip elevations" to which both concrete and steel piling had to be driven into the ground at each pier location, the contract also specified an "estimated tip elevation" for each pier location as follows:

> Approximate elevations of pile tips shown on the Plans have been estimated from boring information, but are not to be considered final. It will be the Contractor's resonsibility to determine the pile lengths from test piles.
>
> * * *

Contract Special Provisions, pages 73 and 79.

Regarding the "minimum tip elevations" for the piers and the "estimated tip elevations" for the piers, in summary, the contract gave the contractor two reference points: 1) the minimum tip elevation and 2) the estimated tip elevation. The contract required the contractor to drive the pile at least to

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[11]For the 14" steel bearing piles, a similar provision in the Contract Special Provisions regarding the required minimum tip elevation includes the phrase "of the test piles" before the phrase "of the pile load tests" (Contract page 73). This phrase is not included with the phrase "pile load tests" (page 79) when describing the minimum tip elevation requirement for the prestressed concrete piles.

the minimum tip elevation shown for each pier although piles were expected to drive deeper than the minimum tip elevation. In this regard, the contract plans show the estimated tip elevation at each pier location to be at least as deep as the minimum tip elevation.

As we discussed, the contract estimated tip elevation for each pier indicates the expected point of penetration of each pile into the soil. The contract plans identify the estimated tip elevation in feet below the river's water surface. The estimated tip elevation was SHA's designer's estimate, based on the information he had (boring logs, etc.), of the elevation at which the soil resistance on the bearing pile that had attained its bearing capacity would cause the bearing pile to hold the design load placed on it without failure, i.e., without sinking further into the soil when the design load is placed on it.

In this regard, the designer determines the estimated tip elevation shown on the contract plans by, among other things, review of the site data, including the borings taken, as well as application of engineering parameters to the design load carrying capacity specified for the bridge. The calculations which support the design include calculations of load carrying capacity of each pile supporting the bridge structure. Thus, the expected elevation at which a particular kind of (concrete or steel) pile will reach the required bearing capacity in a soil depends on a number of complex and interrelated physical and engineering factors. The contract representations of the expected bearing capacity of the piling in the soil at this site by way of "estimated tip elevations" at each pier location was the designer's representation of a physical factor involving the actual physical resistance expected of the subsurface soil to the bearing piles driven into it. Stated another

way, the estimated tip elevations represented the physical capacity of the soil to support the piles and bridge based on piling driven in accordance with specified contractual, i.e., engineering parameters.

Accordingly, a Type 1 differing site condition at the South River Bridge site occurred where test piles reached bearing at elevations that significantly varied from the elevations at which bearing was expected to be reached as represented by the contract's estimated tip elevations. A Type 1 differing site condition also occurred where the production piles reached bearing at elevations that varied from the expected elevations as represented by the contract's estimated tip elevations. A differing site condition occurred even though production piles driven subsequent to test piles may have reached bearing at elevations consistent with the elevations at which the test piles achieved bearing capacity, if they varied from the estimated tip elevations. A Type 1 differing site condition thus occurred where the production piles drove to bearing at elevations that materially varied from either the contract's estimated tip elevations or from the elevation's at which the test piles attained bearing at a pier.

The coincidence that the test piles and the production piles achieved bearing at consistent elevations, however, may affect Appellant's damages or equitable adjustment. Once the test piles driven at each pier indicated that piles were reaching their bearing capacity at elevations that differed materially from the estimated tip elevations represented in the contract plans, Appellant had information that permitted it to make adjustments and order piling from the manufacturer of sufficient lengths necessary to attain bearing at elevations indicated by the elevations at which the test piles reached their bearing capacity. Appellant potentially could mitigate some of its costs at piers where the production piles ordered drove to elevations consistent with

those indicated by the test piles although the test piles had driven to bearing at elevations that differed materially from the contract's estimated tip elevations.

Thus Appellant has the burden of proof to show the extent of any increase in its costs or time required for performing any part of the work due to the material variance between the test pile elevations and the contract's estimated tip elevations or due to the material variation between the production pile elevations and the contract's estimated tip elevations. Stated another way, the contract assigned Appellant the responsibility to order the appropriate lengths of production piles based upon the actual elevations at which the test piles achieved bearing capacity at a pier location, although there was a Type 1 differing site condition due to the discrepancy between actual subsurface soil conditions and the represented subsurface soil conditions.

The material variation in elevations at which pile bearing was achieved across a pier at a particular pier location also constituted a Type 2 differing site condition under the circumstances experienced under this contract. Material variations in bearing elevations from pile to pile across a pier and particularly between adjacent piles constituted abnormal and unusual conditions in this area of the South River, although some variation in bearing elevations normally would be expected to occur during pile driving. (Friets Testimony App. Exh. 1003-50/18; Tr. 20-67/8; 3-120/2; 3-120/1; Exh. 97; [see Appellant's Initial Brief, pp. 49-54). Where production piles driven reached bearing capacity at elevations that varied materially from both the contract's estimated tip elevations and the elevations at which the test piles attained bearing a Type 2 differing site condition occurred. This condition of

a variation between test pile elevations and production pile elevations is unusual and differs materially from those pile driving conditions ordinarily encountered in this area.

We next discuss what occurred during the driving of the test piles to bearing and the driving of the production piles to bearing at each pier location that used 18" x 18" prestressed concrete piles as part of the bridge support structure. After discussing the concrete piers, we discuss Piers 13 and Piers 14 which are supported by the 14" x 89 lbs steel H Piles.

Pier 1. This was a land pier as opposed to a water pier. For our purposes, a water pier is a pier supported by piling located within the boundaries of the river. The piles at a water pier are driven into the ground below the water line. The contract plans specified the minimum tip elevation for Pier 1 as approximately -15', that is 15 feet below 0.0' elevation, which the contract specified as mean low water (M.L.W. = 0.0'). The contract plans located the estimated tip elevation and the minimum tip elevation at approximately the same elevation, i.e., at -16'. The two test piles drove to depths that were 21 feet (elevation: -37') and 37 feet (elevation: -53') deeper than the estimated tip elevation of -16'. Production piles drove to bearing at elevations short of, between, and as long as the elevations indicated by the test piles. (App. Exh. 250). Both the test piles and the production piles reached bearing elevations that materially varied from that shown by the contract plans. (App. Exh. 250). Significant cutoffs of piles were required for the production piles that drove to bearing short of the expected bearing elevation indicated by the contract's estimated tip elevation. A Type 1 differing site condition occurred within the meaning of the Differing Site Conditions Clause, although

Appellant did not complain to the SHA procurement officer specifically that the differing site condition that occurred extended to the location of this particular land pier.

Pier 2. A differing site condition was not alleged and did not occur at this pier location. The test piles and production piles attained load bearing capacities at the approximate elevations indicated by the contract estimated tip elevations for Pier 2.

Pier 3. A differing site condition was not alleged and did not occur at this pier location.

Pier 4. The contract plans indicated the estimated tip elevation at -34'. The two test piles driven on each side of the pier reached bearing near the elevations indicated by the contract's estimated tip elevations. The test pile on the east end[12] of the pier location drove to bearing at the -34.9' elevation. The test pile driven on the west side of the pier location drove to bearing at an elevation of -35.8'. The production piles reached bearing at or near the estimated tip elevation indicated in the contract. (Resp. Exh. 387). Neither the test piles nor the production piles drove to bearing at elevations that materially varied from the estimated tip elevations shown on the contract plans. A Type 1 differing site condition did not occur at the Pier 4 location. Production pile were driven at the rate of 9.33 piles per day (28 piles in three days).

Pier 5. Both test piles reached bearing capacity at an elevation that was approximately 10 feet below the estimated tip elevation indicated by the contract. Production piles were ordered based on the depth at which the test piles reached bearing. Most of the production piles reached bearing at

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[12]We have followed the convention used throughout by SHA and Appellant that the east end of a pier is the end of the pier indicated by the Pile No. 1 location, although the contract plans and specifications indicate that Pile No. 1 at each pier was at the west end.

elevations that were consistent with the elevations at which the test piles achieved bearing. However, two production piles drove approximately 22-25 feet deeper than the elevations reached by the test piles. Further, two other production piles reached bearing capacity at elevations that were consistent with the contract's estimated tip elevation bearing leaving approximately 10 and 15 feet, respectively, of piling sticking out of the water which had to be cutoff. The test piles and the production piles drove to bearing uniformly across the pier and reached bearing at elevations that did not materially vary from the estimated tip elevation shown on the contract plans, except for 3 piles. A Type 1 differing site condition did not occur. (App. Exh. 251). Production piles were driven at the rate of 12 piles per day (12 piles in one day).

Pier 6. The contract plans set the estimated tip elevation for this pier at an elevation of -35'. The two test piles drove to bearing at elevations of approximately -50'. The production piles reached their bearing capacity at approximately the same elevations at which the test piles reached their bearing capacity although the production piles drove to bearing at uniform elevations across the pier. The production pile elevations at which bearing capacity was achieved ranged from approximately -48' to -52'. The test piles and the subsequently driven production piles thus attained bearing at consistent elevations although these elevations varied by as much as 17 feet from the estimated tip elevation shown in the contract plans for this pier location. A Type 1 differing site condition occurred due to the material difference between the contract's estimated tip elevations and the elevations at which the test piles and production piles attained bearing. Production piles were driven at the rate of 2.28 piles per day (32 piles driven in 14 days).

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Pier 7. Appellant did not allege that a differing site condition occurred at this location. Actual driving of the test piling and production piling did not indicate that a differing site condition occurred. Production piles were driven at the rate of approximately 4.25 piles per day on the average (Tr. 5-85/13, Womack).[13]

Pier 8. The minimum tip elevation was set at -40'. The contract indicated the estimated tip elevation as -45'. The test pile on the east side of the pier location drove to a depth greater than -65', a variaton of 20 feet from the estimated tip elevation, or a 144% increase in the test pile depth over the depth of the estimated pile tip elevation as indicated by the contract. The production piles driven near the test pile on the east side of the pier reached bearing at elevations varying from approximately -48' to approximately -65'.

On the west side of Pier 8, the test pile drove to approximately -44'. Production piles driven on the west side of the pier generally reached bearing short of the test pile elevations but ranged from -44' to -47'. (App. Exh. 252). Appellant had cutoffs across Pier 8 ranging from lengths of 13 feet to lengths approaching 25 feet. The cutoff lengths for the production piling generally were greater for production piles driven on the west side of Pier 8. This is understandable as the piles on that end of the pier drove close to the estimated tip elevation, although Appellant acting conservatively and reasonably had chosen to drive longer piles based on the deeper depths indicated by the test pile on the east end of the Pier 8 location. The test piles and production piles indicate a non-uniform sloping bearing strata across the Pier 8 location.

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[13](Tr. 5-85/13) - This type of notation is used to reflect the "(Volume of Transcript-Page/Line)".

At Pier 8, Appellant experienced significant variations in elevation at which the piles achieved bearing. It had to make significant cutoffs ranging up to 25 feet in length for piles near the test pile located at the Pile No. 27 position. A differing site condition occurred. (App. Exh. 252). Appellant drove production piles at the rate of 2.89 piles per day (26 piles in nine days).

Pier 9. The contract plans indicated a minimum tip elevation of -52'. The contract indicated the estimated tip elevation at -58'. One test pile drove to bearing at -66' and one at -67'. One of the test piles was not driven pursuant to the MEN Formula but was driven to criteria that encompassed SEN Formula requirements. This test pile was the pile that was test loaded for the required Pier 9 load test that was discussed regarding Appellant's Pier 9 load test claim. Appellant generally drove the production piles uniformly across Pier 9 to bearing at elevations within 10 feet of the estimated tip elevation although at a deeper elevation and consistent with the elevations at which the test piles reached bearing and some of these production piles reached bearing at elevations that approached the -70' elevation. However, ten production piles unexpectedly drove to elevations short of the contract's estimated tip elevation on the west side of Pier 9. Several of these piles drove to bearing at or short of the contract's minimum tip elevation. This required unexpected and material cutoffs of greater than 10 feet in 10 of the 41 piles.

A differing site condition occurred because some of the piles reached bearing at elevations significantly shallower than the estimated tip elevations shown on the contract plans requiring cutoffs of piling greater than 10 feet.

This was greater than reasonably should have been anticipated. Appellant drove the production piles at Pier 9 at the rate of 4.4 piles per day (40 piles in nine days).

Pier 10. The minimum tip elevation was -52'. The estimated tip elevation was -58', the same parameters that the contract plans established for Pier 9. The test pile driven on the east side of the pier reached bearing at approximately -78', and the one driven on the west side reached bearing at approximately -77'. Many of the production piles drove to bearing at elevations approximately 20 feet below the estimated tip elevation. Production piles drove to bearing at varying elevations on the east side of the pier. Some production piles on the east side of the pier reached bearing at elevations that significantly varied from the elevations at which the test piles reached bearing. A number of the production piles drove uniformly, particularly those on the west side, and reached bearing consistent with the test pile elevations, although at elevations significantly below the estimated tip elevation. Others attained bearing at elevations between the contract estimated tip elevation of -58' and the bearing elevations achieved by the test piles. One production pile reached bearing at an elevation between the minimum tip elevation and the estimated tip elevation. One production pile drove short of the minimum tip elevation. Actual conditions experienced at this pier were abnormally erratic. Cutoffs on both the east side and west side of Pier 10 ranged from a few feet on the west side to cutoffs of approximately 31 feet on the east side. A differing site condition occurred because the elevations at which the piling reached bearing varied materially from the estimated tip elevations at which piling was expected to achieve bearing as represented by the contract

plans. Appellant also had to make a number of cutoffs where piles took up short of their expected bearing elevations. (App. Exh. 254). Appellant drove the production piles at the rate of 2.7 piles per day (41 piles in 15 days).

Pier 11. The contract minimum tip elevation was -52'. The contract specified the estimated tip elevation as -60'. The test piles drove to bearing at approximately -79' on the east side of the pier location and to -77' on the west side of the pier location. Appellant experienced seven cutoffs at this pier. The production piles generally drove to their bearing capacity at uniform elevations across the pier, that is, to depths ranging from -68' to approximately -78'. One production pile drove to bearing at approximately -50', ten feet shallower than expected from the contract estimated tip elevation, and had to be cutoff. A differing site condition occurred because of the material variation that occurred between the actual tip elevations at which the test piles and production piles reached bearing when compared to the estimated tip elevation for this pier. However, Appellant drove 34 production piles in three days at Pier 11 for a pile driving rate of approximately 11 piles per day.

Pier 12. A differing site condition occurred at this pier location. (Finding of Fact No. 26). SHA's expert, Mr. Trauner, found that Appellant encountered a differing site condition. Appellant drove the production piles at the rate of 3.5 piles per day. (28 piles in eight days).

Piers 13 and 14. These piers involved driving 14" x 89 lbs steel test piles and 14" x 89 lbs steel production piles and are addressed below.

Pier 15. The contract specified the minimum tip elevations as -99'. The estimated tip elevation was set at -106'. (App. Exh. 249). Appellant drove the test piles to bearing at elevations consistent with the contract estimated tip elevation of -106', although one test pile had excess piling of approxi-

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mately 17 feet above the +1' cutoff elevation. (Resp. Exh. 389). Production piles drove to bearing at uniform elevations across the Pier 15 location consistent with the elevations indicated by the contract's estimated tip elevation. Production piles were driven at the rate of 3.7 piles per day (26 piles in seven days). A material variation from expected conditions as represented by the contract, i.e., by the contract estimated tip elevations for Pier 15, did not occur at this pier location. There was no differing site condition at this pier.[14]

Pier 16. A differing site condition is neither alleged nor occurred at this pier location. Appellant drove the production piles at the rate of 3.2 piles per day. (32 piles in ten days).

Pier 17. The minimum tip elevation set by the contract was -80'. (App. Exh. 249). The estimated tip elevation represented by the contract was -85'. One test pile drove to bearing at approximately -99' and one drove to bearing at approximately -100'. Production piles drove to bearing elevations across the pier that were uniformly consistent with the elevations indicated by the test piles, although the elevations at which the production piles reached bearing ranged in elevations from approximately -94' to -100'. (Resp. Exh. 390). A differing site condition occurred because of the significant variation between the contract's estimated tip elevations and the elevations at which the test piles and the production piles reached bearing. This variation ranged from approximately 10 feet to approximately 16 feet. Appellant drove the production piles at the rate of 8.25 piles per day (33 piles in 4 days).

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[14]Pier 15 is an example of what Appellant reasonably should have expected to occur during performance of this contract. The contract set the estimated tip elevation. Appellant drove the test piles to bearing at elevations that were within several feet of the estimated tip elevation thus verifying the contract's estimated tip elevation. It ordered its production piles and then it drove them to bearing at elevations consistent with the estimated tip elevations that had been verified by the test piles.

Pier 18. The contract set the minimum tip elevation at -58'. The contract represented the estimated tip elevation at -61'. The test piles drove to bearing at elevations ranging from approximately -79' and -95', a difference of 18' and 34', respectively, from the -61' estimated tip elevation indicated by the contract plans. Appellant drove 41, 96' long production piles at this pier in 12 days for a pile driving rate of 3.4 piles per day. Several of the production piles broke during driving because of their very long lengths. Replacement piles had to be driven at those locations.

At Pier 18 the actual elevations at which the piles achieved their load bearing capacity varied materially from that expected as indicated by the contract's estimated tip elevation. A differing site condition occurred.

Pier 19. The contract set the minimum tip elevation at approximately -37.' The contract's estimated tip elevation was set at approximately -38'. (App. Exh. 249). The test pile on the east side of the pier location drove to bearing at an elevation of -40'. The test pile on the west side of the pier achieved bearing at an elevation of -36', roughly one foot short of the minimum tip elevation. (App. Exh. 255). However, the concrete production piles driven on the east side of the pier drove to bearing at varying elevations ranging from approximately -42' to -65'. On the west side of the pier the production piles drove to bearing at elevations ranging from elevations of approximately -44' to -78.' Appellant made major cutoffs of piling at Pier 19. While seven piles required no cutoffs, fifteen production piles had cutoffs greater than approximately twenty feet. There were a number of cutoffs of approximately 30 feet in length with at least two cutoffs of approximately 36 feet. (App. Exh. 255). Appellant drove 28 production piles in 13 days, a rate of 2.15 piles per day.

The actual conditions at which the piling achieved bearing varied significantly from the estimated tip elevation indicated in the contract plans. Based on its driving experience at Piers 18 and 20, Appellant reasonably chose to order 78 foot long piles even though the estimated tip elevation was set at approximately -38' for Pier 19 and the test piles driven verified the estimated tip elevation at approximately -38. Had Appellant not chosen the longer 78 foot production pile lengths in a number of instances the production piles would have been too short to reach the depths necessary to achieve bearing capacity. In some instances, the actual elevations at which the piles achieved bearing were 30-40 feet below the Pier 19 estimated tip elevation. (App. Exh. 255). If the piles had been too short Appellant would have been required to do the additional work of pulling these production piles, driving longer piles, or splicing piles. (App. Exh. 255). Appellant mitigated some of its damages by choosing the longer piles based on its pile driving experience at Piers 18 and 20, although its driving experience with the test piles at Pier 19 had indicated that production piles approximately 45 feet long would be required (40 feet to bearing plus six feet of cutoff). However, Appellant still had to make significant cutoffs of piling.

A differing site condition clearly occurred at Pier 19 due to physical conditions that varied materially from the subsurface conditions indicated by the contract's estimated tip elevations. That is, the differing site condition is shown by piling that reached their bearing capacity at elevations which differed materially from the elevations represented by the contract plans.

Pier 20. The contract specified the minimum tip elevation as -40'. The estimated tip elevation was shown as approximately -46'. (App. Exh. 256). The test pile on the east side of the pier location drove to bearing at approximately -67'. The test pile on the west side drove to bearing at -48'.

The elevations at which the production piles reached bearing across this pier varied erratically from pile to pile ranging from an elevation of -43' (between the minimum tip elevation and the estimated tip elevation) to elevations as great as -75'. There was an overall a difference in elevations at which piles reached bearing capacity across the pier of approximately 32 feet. The difference in depths between the elevations at which the two test piles attained bearing was approximately 19 feet. (App. Exh. 256). Fourteen piles required significant cutoffs ranging in lengths of up to approximately 29 feet. At Pier 20, Appellant drove 28 production piles in nine days for a driving rate of 3.1 piles per day.

A differing site condition existed at Pier 20 based on the materially irregular elevations at which the production piles attained bearing across the pier, the significant variation of at least 10 feet between the estimated pile tip elevation for Pier 20 and the elevations at which the production piles attained bearing, and the significant number and lengths of cutoffs that Appellant had to make when piles took up at relatively shallower elevations than reasonably expected from review of the contract plans.

Pier 21. The contract minimum tip elevation was set at -31' and the estimated tip elevation was set at -32'. (App. Exh. 249). A differing site condition did not occur at this pier location. The elevations at which the test piles reached bearing did not materially vary from the contract's estimated tip elevation. The production piles reached their bearing capacity generally at elevations that did not materially vary from the contract's estimated pile tip elevation.

Pier 22. The contract set the minimum tip elevation at -22'. (Resp. Exh. 391). The contract plans represented the estimated tip elevation at approximately -23'. The test pile on the east side of the pier location drove to

bearing at an elevation of approximately -25'. The test pile on the other side of the pier drove to bearing at an elevation of approximately -26'. (App. Exh. 249).

The production piles drove to bearing at elevations ranging from approximately -27' to -30'. The elevations at which the production piles attained their bearing did not vary materially from the elevations indicated by the estimated tip elevation set forth in the contract plans or from the elevations at which the test piles attained bearing. (Resp. Exh. 391). A differing site condition did not occur. Appellant drove the production piles at the rate of approximately 4.25 piles per day on the average. (Tr. 5-85/13, Womack).

Pier 23. The contract set the minimum tip elevation at -22' and the estimated tip elevation at -23'. (App. Exh. 249). A differing site condition is neither alleged nor occurred at this pier location. Appellant drove the production piles at the rate of 5.2 piles per day (26 piles in five days).

Pier 24. This pier was a land pier. No differing site condition is alleged or occurred at this pier location. Appellant drove the production piles at this pier at the rate of 7.3 piles per day (22 piles in 3 days).

Pier 25. Pier 25 was the last pier location on the north end of the new South River Bridge structure. This was a land pier. No differing site condition is alleged or occurred at this pier location.

Pier 13 & Pier 14.

A differing site condition within the meaning of the differing site conditions clause occurred at the Pier 13 and Pier 14 locations. The 14" steel piles reached bearing at elevations that materially varied from the elevations indicated by the estimated tip elevations set forth in the contract plans.

The deep driving of the piles evidenced conditions of soil resistance that were unknown at this site and were unusual and differed materially from those conditions ordinarily encountered.

Pier 13. The contract required Appellant to drive four, 14" steel test piles. The test piles were to be left in place to become production or permanent piles once driven to bearing. The contract plans required Appellant to drive 92 production piles across the length and width of the Pier 13 location. The contract specified an elevation of approximately -73' for the minimum tip elevation. The contract set the estimated tip elevation for Pier No. 13 at -80'.

The four test piles reached bearing at elevations of approximately -105', -113', -119', and -101', respectively, well past the estimated tip elevations indicated by the contract plans. The elevations at which these test piles attained bearing varied from the contract's estimated tip elevations by approximately 25', 33', 39', and 21', respectively.

The 14" steel production piles reached bearing across Pier 13 at elevations that ranged from approximately -80' to -100' on the eastern side of Pier 13 to elevations of approximately -126' toward the middle of the pier and to elevations of approximately -95' to -101' on the western end of the pier. Thus, in the middle area of Pier 13 production pile bearing elevations varied from approximately -82' to approximately -126', a difference of approximately 43 feet in depth for steel piles driven at approximately the same location. (App. Exh. 247).

In one area toward the western end of Pier 13, a production pile drove to bearing at an elevation of approximately -125' with adjacent piles driving to shallower depths at elevations ranging from approximately -102' to -108'. In

this same location, other production piles generally reached bearing between elevations of approxiately -93' to -100', although one of them drove to bearing at an elevation of approximately -105'. (App. Exh. 247).

The elevations at which the piles driven at Pier 13 reached bearing varied materially from the contract's estimated pile tip elevation and were variations not ordinarily expected for this area. In addition, the elevations at which the 14" steel piles reached their bearing capacity varied materially from one location to another across the pier location, although the piles generally tended to drive to bearing at deeper elevations at the center portion of the pier. The bearing elevations of piles driven from the east side of the pier to the west side would resemble an inverted Bell Shaped Curve if they were to be plotted on a graph. The bearing elevations are shallow at both sides and become deeper in the middle of the pier location. (Exh. 247; App. Exh. 248).

Pier 14. Pier 14 also called for four 14" x 89 lbs steel test piles and 92 permanent or production piles. (App. Exh. 248). The contract specified a minimum tip elevation of approximately -97' and an estimated tip elevation of -105'. The four test piles driven reached their bearing capacities, respectively, at elevations of approximately -112', -125', -180', and -181' moving from the eastern end of the pier to the western end. (App. Exh. 248).

The elevations at which the 14" steel production piles reached bearing show a marked contrast between the eastern half of Pier 14 and the western half. On the eastern half or side of Pier 14, the steel piles drove to their bearing capacities elevations ranging from as little as -103' (slightly shallower than the contract's estimated tip elevation) to as deep as -182' a variation of -79'.



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There were approximately 53 production piles driven from a point in the middle of the pier location to the eastern side of this pier. Of these, approximately 23% (12 of 53 piles) drove to bearing at elevations deeper than -160'. However, approximately 66% (35 of 53 piles) drove to bearing at elevations less than the -120' elevation. (App. Exh. 248). Many of these latter 35 piles reached bearing generally near the -110' elevation.

The western side of Pier 14 shows an entirely different picture. A large percentage of the piles, well above the majority of piles (85%, 41 of 48 piles) drove to their bearing capacities at elevations below -160', with many of them driving to bearing at uniform elevations of approximately -180'. Not one 14" steel production pile reached a bearing elevation of less than -120', although one pile reached bearing at an elevation of -120'. (App. Exh 248).

SHA agreed that the pattern established at Pier 14 by the elevations at which the piles reached their bearing capacities indicated that there was a shelf of dense subsurface material running across the pier location from east to west with the shallower edge of this shelf starting on the eastern end of the pier and running at a downward angle across the Pier 14 location toward the western end of the pier. The physical conditions at Pier 14 materially varied from the conditions indicated by the contract's estimated tip elevations, as demonstrated by the contractor's pile driving experience, and clearly indicate that a differing site condition existed as defined by the contract's Differing Site Conditions Clause. These physical conditions also were unknown, unusual and differed from those conditions ordinarily encountered or expected at this location.

Based on the above discussion of the subsurface conditions encountered by Appellant when driving the concrete piles and the steel piles at the piers across the South River, we find that a differing site condition within the

meaning of the Differing Site Conditions Clause occurred at the South River Bridge construction site as evidenced by the physical driving conditions Appellant experienced at Pier Nos. 6, 8, 9, 10, 11, 13, 14, 17, 18, 19, and 20. In this regard, SHA's expert witness stated his view regarding the concrete piles that a subsurface condition materially varying from that shown in the contract plans and specifications existed at Piers 6, 8, 9, 10, 11, 12, 17, 18, 19 & 20. (Tr. 19-71/12, 72/14, 101/24; Exh. 355, p. 75). SHA's expert also agreed that there was a differing site condition at Pier 14. (Tr. 86/24; Exh. 392).

In summary, as to the 18" concrete piles Appellant demonstrated the existence of a differing site condition. Appellant established a material difference between contract's representation of subsurface conditions at the site as indicated by the contract estimated tip elevations (the location where SHA represented the piles would achieve bearing capacity based on the subsurface resistance of the soil) and the actual subsurface, physical conditions that occurred at the site as indicated by the actual elevations at which piles achieved their bearing capacities. A material variation occurred if piles did not achieve bearing capacity within 10 feet of the estimated tip elevations shown in the plans and specifications for those piles that drove to bearing at elevations deeper than the contract's estimated tip elevations. As we said, it was reasonable for Appellant based on a review of the contract plans to reasonably expect that the test piles and production piles would reach their bearing capacities within ten feet of the estimated tip elevations. The plans indicated that SHA would pay Appellant as part of the contract unit price for piling five feet beyond the cutoff point of +1' above 0.0 ft. elevation. In addition, a ten foot cutoff indicating a ten foot variation in pile bearing depths, was a reasonable variation that ought to be ordinarily

expected for pile driving work at the South River Bridge site. And Appellant in its bid anticipated at least a five feet variation from estimated tip elevations in addition to the five feet above the cutoff point allowed by the contract. For similar reasons, as discussed a differing site condition occurred at Piers 13 and 14. (Friets Testimony, pp. 33-36, 43-45).

We also find, as we stated, that a Type 2 differing site condition occurred given the significant variations (greater than ten feet) in elevations at which piles achieved their bearing capacity within and between piers during both the test pile phase and the production pile phase of the contract work. Such variation in depths of elevation when driving piling in this site area is unusual and not ordinarily encountered. (Friets Testimony, App. Exh. 1003-50/18).[15]

II. Quantum

a. General

We subscribe to the principle that Appellant is entitled to an equitable adjustment based on the difference between what it should have reasonably cost to perform the contract work required by the contract and what it reasonably cost to perform the work as changed as a result of the differing site condition. However, Appellant must prove by a preponderance of the evidence that the changed circumstances attributable to the differing site condition caused an increase in its costs above the costs reasonably antici-

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[15]Aside from its position under the contract's Differing Site Conditions Clause, Appellant also contends that the 120% overdriving requirement mandated by SHA's designer was a key reason why the bearing elevations attained varied from the estimated tip elevations set forth in the contract plans. Appellant thus argues that when SHA required Appellant to drive piles to 120% of design load the result was to overdrive the piles to bearing at elevations beyond that indicated by the contract's estimated tip elevations which the designer specified in the contract plans. There is no need to resolve this issue, however, so as to decide if this is a plausible explanation of why the driving conditions, i.e., the subsurface site conditions, varied from the driving conditions as indicated in the contract plans by the estimated tip elevations.

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pated. See N. Fiorito Company, Inc. v. United States, 189 Ct.Cl. 215, 416 F.2d 1284 (1969); C.H. Leavell and Company, ENG BCA No 3492, 75-2 BCA ¶11,596 (1987); Tompkins & Co., ENG BCA No. 4484, 85-1 BCA ¶17,853 (1985). See generally Modern Foods, Inc., ASBCA No. 2090, 57-1 BCA ¶1229 (a proper equitable adjustment is the difference between what it would have reasonably cost to perform the work as originally required and what it reasonably cost to perform the work as changed.)

We find that Appellant's costs were increased by the differing site condition. We further find that Appellant reasonably should have been able to drive the concrete piling at the rate of at least six piles per day, and the steel piling at the rate of six piles per day. Appellant's pile driving rate was approximately four piles per day (3.7 piles per day overall and 4.25 piles per day at so-called good piers) piles per day on the average for the concrete piers and 3.4 piles per day on the average for the steel pile piers.

Appellant achieved reasonbly good pile driving rates on Pier 11 (11.3 piles per day), although a differing site condition occurred at that pier. This may be explained by the fact that the actual elevations at which the piles achieved bearing were reasonably uniform across the pier although significantly deeper than the contract's estimated tip elevation for that pier. By contrast, for example, Appellant achieved a pile driving rate of only 3.7 piles per day at Pier 15 where there was no significant variation between the estimated tip elevation, the test pile elevations, and the production pile elevations. (Resp. Exh. 389; [see Appellant's Reply Brief, p. 33]). And at Pier 16, Appellant attained a driving rate of only 3.2 piles per day, although there was no material variation between the contracts represented conditions and actual driving conditions. (Exh. 172; Exh. 356, p. 22).

We conclude from the entire evidence of record therefore that Appellant's pile driving problems (excluding the splicing operations required) were somewhat more impacted by the variations in the elevations at which individual piles at each pier attained bearing rather than than by the variation between the contract's estimated pile tip elevations and the actual elevations at which piles attained bearing at a particular pier location. In this regard, where the piling drove deeper than anticipated at some piers but also drove to their bearing capacities at consistent depths, work crews were able to attain a pile driving production level above a learning curve level for those particular piers and thus were able to achieve reasonably uniform pile driving rates for those piers. We are not thus persuaded that a comparison between a "should have been driving rate" and the actual driving rate Appellant experienced is appropriate to compute damages using Appellant's calculation method.

Here, Appellant based its bid on the quantity of piling set forth in the IFB. As we said above, this quantity correlates directly with the depth of piling indicated by the contract estimated tip elevations for each pier location. This quantity of piling almost exactly matches the quantity of piling in terms of the length of pile required that is derived from the "estimated pile tip elevations" shown on the contract plans for each pier location. The estimated pile tip elevations, as represented in the contract documents on which Appellant based its bid, are the benchmark for determining whether there was a differing site condition or change. As well, the contract's estimated tip elevations for each pier location establish benchmarks that can be used to measure the impact of the differing site condition for purposes of determining Appellant's equitable adjustment.

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SHA argued that there was no differing site condition at those piers where the actual elevations at which the production piles achieved bearing did not vary from the actual elevations at which the test piles reached bearing, even when the test pile elevations varied from the estimated pile tip elevations set forth in the contract. As we held above, the Type 1 condition is determined based on representations in the contract documents.[16] We thus disagree with the SHA position as it affects SHA's liability, although its theory does come into play regarding quantum calculations.

In analyzing the quantum issues once again one must distinguish between the bridge that Appellant contracted to build and the bridge it actually built. Appellant's equitable adjustment thus depends upon the extent that the change in circumstances caused it increased costs and those increased costs can be attributable to SHA under the terms of the contract. And, as stated above, Appellant has to show how the material variance in production pile elevations from the contract's estimated tip elevations impacted its costs once it had obtained driving information from the test pile program.

SHA maintains that Appellant was not in fact damaged with respect to those piles driven to depths greater than the contract's estimated tip elevations. SHA points out that this was a unit price contract based on dollars per linear foot of pile driven and that Appellant was paid at the contract unit prices for the additional length of pile driven. Thus, according to SHA, Appellant received greater compensation than it anticipated when it had to drive piles to deeper elevations because its fixed costs did not change.

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[16]SHA's expert witness, Mr. Trauner's, theory is that a differing site condition occurred only if there was a significant variation between the production pile elevations and the test pile elevations. (Resp. Exh. 392, p. 53). His theory is erroneous and we reject it.

In a unit price contract, however, all costs might not be recovered by the unit prices bid by a contractor at the time of contract formation if, as in this instance, quantities significantly greater than anticipated are encountered. See A.S. Horner, supra; See Pennsylvania Department of Transportation v. Trumbull Corp. , 513 A.2d 1110 (Pa. Comm. W. 1986). As Appellant points out, for example, piling longer than reasonably anticipated often required additional splicing and related piling operations which increased costs beyond those anticipated and covered by the unit price. Appellant further points out that the longer piles were more difficult to pick up by the crane and place in the driving leads during preparation for driving, and different and additional crew members and equipment were required. Also, long piles that had to be cutoff because they reached bearing short of the bearing elevation anticipated required different cutoff methods, different size crews, and equipment, and resulted in greater time and expense than cutoffs of shorter piling less than 10' feet in length. A cutoff greater than 10 feet in length, as we said, is our measure of a material variation in length from the cutoff lengths that should have been anticipated from the contract specifications.

Under the express provisions of the Differing Site Conditions Clause, Appellant is entitled to any impact costs that it incurred above what it was paid on a unit price basis by way of an equitable adjustment, A.S. Horner, Inc., supra. Appellant thus is entitled to an equitable adjustment to the extent it demonstrates that its reimbursement based on the contract unit prices did not recoup its increased direct costs caused by the differing site condition. See Kenko, Inc. v. Loury Hill Construction Co., 392 N.W. 2d 18 (Minn. App. 1986); Pennsylvania Dept. of Trans. v. Trumbail Corp., supra. Thus, if a segment of the contract work took longer to perform than reasona-

bly anticipated, although it was performed within the overall contract time allowed, the work necessarily required more labor and equipment hours, i.e., the direct costs to perform increased over those anticipated.

SHA, however, contends that Appellant's costs did not increase in its costs due to any noncritical delays, meaning delays to segments of work that did not result in an overall delay to the contract, and, that it did not suffer a cost impact on the overall job due to any impact of the differing site condition at those piers where there was no differing site condition. We reject SHA's argument. If Appellant's costs of performance increased due to the differing site condition, Appellant is entitled to an equitable adjustment for such costs, however occurring, even if overall contract performance time did not extend beyond the contract time allowed. Performance within the contract period, however, eliminates recovery for contract delay type costs, e.g., extended overhead.

Calculation of the amount due Appellant because of the differing site condition requires an analysis of the proofs of quantum placed in the record by the parties. We use the "jury verdict" in this decision in part method to arrive at a final equitable adjustment, since Appellant proved that it was damaged in fact. In this regard, we adhere to the following principle:

> The ascertainment of damages, or of an equitable adjustment, is not an exact science, and where responsibility for damage is clear, it is not essential that the amount thereof be ascertainable with absolute exactness or mathematical precision. 'It is enough if the evidence adduced is sufficient to enable a court or jury to make a fair and reasonable approximation.'

Granite Construction Co., 1 MSBCA 66 (1983), at 34 (quoting Electronic & Missile Facilities, Inc. v. United States, 189 Ct. Cl. 237, 416 F.2d 1345 1969); Calvert General Contractors Corp., MDOT 1004, 1 MSBCA ¶5 (1981).

In summary, Appellant is entitled to an equitable adjustment for the cost impacts of the differing site condition in the amount of $188,940.39 plus an amount for pre-decision interest to the date of this decision. Appellant's cost increase due to the differing site condition includes the increased cost impacts incurred for additional splicing of piling onto piles caused by the unanticipated deep driving of piles, increased costs incurred due to cutoff of piling required by the unanticipated short driving of piles, increased costs caused by having to abandon piles driven, increased costs caused by the waste of piling for cutoffs greater than the 10 feet anticipated, increased costs due to pulling and redriving of piles, increased costs resulting from the unanticipated additional time needed per pile to drive piles at pier locations where the elevations at which piling reached bearing varied materially within the pier location, and the impact costs caused by the inefficiencies occurring in Appellant's performance methods as a result of the differing site condition.

The estimated tip elevations set forth in the contract are the starting point for determining whether the conditions that Appellant encountered caused an increase or decrease in its cost of, or the time required for, performance of any part of the work under the contract, whether or not changed as a result of such conditions. (Contract General Provisions, paragraph 104.04, "Differing Site Conditions"). The contract specifications indicated to contractors that they could expect at least a five foot variation in the length of each pile as a reasonable variation. In formulating its bid prices Appellant included an additional five feet of pile length as a "safety factor." Thus Appellant reasonably anticipated a total of 10 feet of variation in the elevations it anticipated from the actual elevations indicated in the contract by the estimated tip elevations. Stated another way, for variations in lengths of up to 10 feet from the estimated tip elevations, Appellant's

price covered its normal pile driving costs, assuming otherwise uniform and normal driving conditions. Therefore, it was not damaged where the variations were less than 10 feet.

Appellant's unit prices, including the amount it allowed for wastage due to pile cutoffs, captures some of its costs plus profit and overhead for driving additional lengths of pile, splicing piles, pulling piles, redriving piles, abandoning piles, and making cutoffs of up to 10 feet in length above the anticipated pile lengths. The anticipated pile lengths referred to are those determined by the length of pile between the contract's estimated pile tip elevations and the cutoff elevation of +1' above the water line for the 18" x 18" prestressed concrete piles. For the steel piles at Piers 13 and 14 it is the length between the estimated pile tip elevations and -25'.

SHA contends that it paid Appellant under the contract unit prices of the contract for the additional linear feet of piling driven below the estimated pile tip elevation at each pier. We have considered such additional payment in calculating Appellant's equitable adjustment. For example, if SHA's payment to Appellant at the unit prices for additional length of piling driven covers Appellant's costs and a reasonable profit despite the differing site condition then Appellant has not suffered a cost impact and is not entitled to additional money by way of an equitable adjustment, even in the face of the differing site condition. However if a long pile reached bearing elevation at an elevation short of the elevation anticipated, Appellant would not receive payment under its unit prices for the length of pile above the cutoff elevation. Also, the contract required Appellant's unit prices to include a price for this waste of piling material above the cutoff elevation. Appellant included a 4% factor in its bid to cover this circumstance.

However, Appellant is entitled to an equitable adjustment to the extent that this factor in its unit price did not cover pile cutoffs of excessive lengths greater than the ten foot variation in pile lengths reasonably expected.

SHA approaches the differing site condition costs on a pier by pier basis. It argues that there were piers where no differing site condition occurred. SHA maintains that at those pier locations for the piles driven[17] Appellant was paid its unit price which covered its costs and thus there was no additional cost impact for which SHA is responsible. As noted above, we disagree with SHA's analysis in this regard.

The Differing Site Conditions Clause applies to secure reimbursement for the contractor for the cost increase to any part of the work, whether or not changed, due to the differing site conditions. Thus, if proved, Appellant is entitled to damages caused by loss of productivity, or loss of efficiency, at "good piers", i.e., at those piers where the piles drove to bearing at elevations consistent with the elevations set forth in the contract plans, if the loss of productivity is shown to have been caused by driving of piles at "bad piers", i.e., at those piers where actual pile bearing depths attained varied significantly from those represented. In this regard, we should perhaps repeat that we have found that the whole site involved a differing site condition (both Types 1 and 2).

b. Quantum Calculations

Appellant's equitable adjustment is determined as follows.

18 Inch Prestressed Concrete Test Piles Bid Item 408.

[17] We use "driving" in the broad sense to include all those steps necessary to place the piles, including pile driving with the hammer, splicing piles, cutoffs, jetting piles, pulling piles, breaking piles, and abandoning piles.

Appellant's actual productivity rate for driving the 18" prestressed concrete test piles was approximately two piles per day. Its loss of efficiency or productivity as a measure of its damage due to the differing site condition would be the difference between the actual pile driving rate achieved and the rate it should have achieved. However, Appellant has not shown its decrease in driving rates was attributable solely to the differing site condition for which SHA is responsible. There were other factors that contributed to Appellant's failure to reach its intended pile driving rate. Appellant is responsible for some of these factors, including equipment breakdowns and failure for no apparent reason tied clearly to the differing site condition to attain intended pile driving productivity at piers ("good piers") where there were no material variations in subsurface conditions, e.g., at Piers 15 and 16. Thus Appellant's methodology for calculating its equitable adjustment does not clearly link its loss of productivity in pile driving rates to the differing site condition sufficiently enough to base a damages decision on its methodology. See Newell Clothing Co., ASBCA No. 28306, 86-3 BCA ¶19,093 (1986).

However, the record establishes the fact of Appellant's damages and provides a basis for calculating Appellant's equitable adjustment, even though we do not follow Appellant's method of calculating its loss of productivity based on an analysis of pile driving rates. See Greiner Engineering Sciences, Inc., MSBCA 1366, __ MSBCA __, (March 28, 1989) 9 at 21. In this regard, we find Appellant is entitled to an equitable adjustment of one work day for the critical delay (delay to the overall work) at Pier 6. Appellant is entitled to four days of noncritical delay in driving the 18" concrete test piles and the resulting costs, although this work for the most part (except see the Pier 6 calculations) was not on the critical path schedule for the project. (SHA

Exh. 356 Appendix F.; Trauner Testimony Tr. 18-63/15; SHA Exh. 357, pp. 47-48, 50-60; SHA Exh. 352 (Rubino & McGeehin Audit Report)). Appellant's equitable adjustment for the 18" prestressed concrete test piles is calculated as follows:

| | | |
|---|---|---|
| Critical Delay (1 workday (WD)) | | |
| Labor - Straight time - $106/hr x 8 hrs (1 workday) (Exh.297) | | $ 848.00 |
| Payroll Taxes & Insurance - $848.00 x .3476 | | 294.76 |
| Field overhead - $8,509/week x 1 wk/5 WD x 1 WD | | 1,701.80 |
| Payroll Taxes & Ins. - $4,484/wk x 1 wk/5WD x 1 WD week | | 896.80 |
| Subtotal A | | $ 3,741.36 |
| Non Critical Delay (4 WD) | | |
| Labor - $106/hr. x 4 WD x 8hrs/WD | | $ 3,392.00 |
| Payroll Taxes & Ins. - $3392 x .3476 | | 1,179.06 |
| Equipment[18], - SHA Exh.357, p. 46 adjusted to 4 WD | | 1,585.82 |
| Maintenance - 37% x $1,585.82 | | 586.75 |
| Fuel Costs - SHA Exh. p. 57 adjusted to 4 WD | | 933.20 |
| Outside Rental Barge $1,500 X 4 WD x 1/22 WD per month | | $ 272.73 |
| | Subtotal B | $ 7,949.56 |
| | Subtotal A+B | $11,690.92 |
| | Profit (10%) | $ 1,169.09 |
| | | $12,860.01 |

[18]SHA's equipment cost calculations are used as the reasonable equipment costs for performance of the additional work caused by the differing site condition.

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| | | |
|---|---|---|
| Add: | Contract Unit Price (Item 408) to drive 5 additional 18" concrete test piles of 367 Linear Feet at $35.00/L.F. (SHA Exh. 357, p. 19; includes profit and overhead) | $12,845.00 |
| | | $25,705.01 |
| | Bond (0.3%) | 77.12 |
| | 18" Concrete Test Pile Equitable Adjustment | $25,782.13 |

18 Inch Prestressed Concrete Production Piles - Bid Item 407.

A reasonable planned rate of production pile driving was 6.0 piles per day for the 18" concrete production pile driving work, although there is evidence that Appellant intended to drive only at a production pile driving rate of 4 piles per day. Appellant's actual pile driving rate averaged approximately 4.25 piles per day, although Appellant only achieved a pile driving rate averaging approximately 2 piles per day at those piers impacted by the differing site condition. However, Appellant's calculations that are based on a comparison of actual and expected pile driving rates is not suitable to use to determine the loss of efficiency or loss of productivity. Appellant's methodology of calculating the differential between its planned, or expected, production rate and its actual production rate is tainted by other occurrences for which SHA is not responsible. For example, Appellant had problems with its low water footer forms (a form into which concrete is poured for the foot or bottom of the bridge's pier support structure) which caused a delay to this project of approximately 5 five months. This delay was not SHA's responsibility. It was a design problem arising between Appellant and its form supplier. (Tr. 5-74/15, Womack Testimony). However, SHA agrees, and we

find, that Appellant performed extra work in completing concrete pile cutoffs for the 18 inch concrete production piles. (SHA Brief, p.155). The extra work required to cutoff the concrete production piles that took up short of the elevations at which they were expected to attain bearing occurred as a direct result of the differing site condition. In this regard, Appellant's equitable adjustment is based on having to make 82 major concrete pile cutoffs at Piers 5, 8, 9, 10, 18, 19, and 20. (App. Exhs. 249, 251, 252, 253, 254, 255, and 256). A major cutoff of a pile is a cutoff greater than 10 feet of pile beyond the length of pile reasonably expected to be driven from review of the contract plans, as measured between the estimated pile tip elevation and the indicated cutoff elevation.

A labor cost of $137.40 per cutoff and a crew cost of $93/hour (SHA Exh. 297-18 inch test pile) yields 1.48 hours per cutoff. For 82 major cutoffs this equates to 122 additional hours (1.48 hours/cutoff x 82 cutoffs = 121.36 hours). SHA calculated the $137.40 per cutoff based on the differential between the actual pile driving costs for Pier 7 which had no cutoffs and Pier 20 which had 15 cutoffs. Pier 7 and Pier 20 were symmetrical as to layout and the number of production piles in each pier. (SHA Brief, pp. 42, 128-29). According to Mr. Trauner, SHA's expert, Appellant's bid included an estimate that there would be a total of 400 cutoffs at $45 per cutoff or a total of $18,000 for Item 407. (SHA Exh. 1; Tr. 19-32/1, Trauner Testimony). Assuming SHA liability, Mr. Trauner provided three methods for adjusting the contract costs to account for the cutoff costs included in Appellant's bid and recovered through the unit prices SHA paid Appellant for contract performance pursuant to contract Item 407. (Trauner, Dec. 9, 1986 Tr. 32-35). We make the adjustment based on Mr. Trauner's second method. We use the $137.40

derived cost for a cutoff based on the actual cutoffs Appellant made and subtract the $45.00 bid for each cutoff. The cutoff figure we use is $92.40. Appellant's equitable adjustment is calculated as follows:

| | |
|---|---|
| Extra work of 122 hours to perform 82 major cutoffs. | |
| Labor costs - $92.40 per cutoff x 82 cutoffs | |
| (Tr. 19-34/19, Trauner Testimony) | $7,576.80 |
| Payroll Taxes & Ins. $7,576.80 x .3476 | 2,633.70 |
| | $10,210.50 |
| Excess waste of material above Appellant's 4% estimate of waste of material. | |
| 192.2 L.F. x $12.50 per L.F. | $ 2,402.50 |
| (see SHA Brief, pp. 53-54). | |
| Subtotal | $12,613.00 |
| Profit (10%) | 1,261.30 |
| | $13,874.30 |
| Bond (0.3%) | 41.62 |
| Subtotal-Labor and Material | $13,915.92 |
| Equipment[19] - 122 hours x $238.32 per hour (SHA Brief, App. A, unnumbered page 5) | $29,075.04 |
| Maintenance 37% x $29,075.04 | 10,757.76 |
| Fuel - SHA Exh. 357, p. 57 at $237.59 per day x 122 hrs. | |
| x 8 hrs. per day | $ 3,623.25 |

[19] Equipment rates are based on SHA's equipment rate calculations.

| | |
|---|---|
| Subtotal - Equipment | $43,456.05 |
| Total - 18" Concrete Production Piles Equitable Adjustment (Labor & Equipment) | $57,371.97 |

14" Steel Test Piles - Pier 13 and Pier 14 - - Bid Item 404.

At Piers 13 and 14, the impacts caused by the differing site condition occurred at Piers 13 and 14 as they did at the other pier locations, although the construction methods differed somewhat because the piles were steel rather than concrete. A different methodology, crew makeup, equipment, etc., are used to cutoff 14" x 89 lbs. steel piles than are used to cutoff the 18" x 18" prestressed concrete piles. For example, concrete saws and a jackhammer are used to cutoff a concrete pile, while a blowtorch is used to cutoff a steel pile. Other operations, e.g. splicing, also require somewhat different construction techniques. Appellant was impacted by having to drive excessively longer piles than anticipated, having to splice piles in the leads, having to make pile cutoffs of excessive lengths, having to abandon piles, and having to remove piles.

In this regard, Appellant incurred a five day noncritical impact delay at Pier 13. (App. Exh. 297, Tr. 4-76/20, 76/2; Resp. Exh. 356, pp. 10-15). SHA caused the confusion that affected Appellant's pile driving operation and resulting impact costs. This occurred because of the question raised at the beginning of pile driving regarding which pile driving formula the contract specifically required Appellant to use to drive the steel piles (i.e. the SEN Formula or the MEN Formula).[20] The delay incurred while SHA determined the

[20]Note, this is a different issue from the one regarding Appellant's request to be reimbursed for the concrete test pile driven at Pier 9 to the SEN Formula

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proper driving formula required by the contract. This delay in interpreting the tract's requirements which SHA accepted as its responsibility as to this issue resulted in five work days of additional crew and equipment time for which SHA is required to reimburse Appellant by way of an equitable adjustment. (SHA Exh. 392, pp. 51-52 (Trauner)).

SHA agrees that the site at Pier 14 differed materially from what was depicted in the contract. There was a shelf of bearing strata which varied across the pier location that caused the resistance of the subsurface soil bearing strata on one side of the pier to be materially different from the resistance of the bearing strata on the other side of the pier. (SHA Brief, p. 137). Appellant thus encountered a differing site condition at Pier 14 as shown by the test piles indicating the shelf. (Tr. 18-142/9, Trauner; Resp. Exh. 392). Appellant's equitable adjustment for the additional work it took to drive 14" test piles at Piers 13 and 14 due to the differing site condition is calculated as follows.

14" Steel Test Piles - Pier 13 and Pier 14 -- Bid Item 404

5 Days Pier 13 Non Critical/Extra Work (Trauner, Dec. 9, 1986 Tr. 48).

5 Days Pier 14 Non Critical/Extra Work (Trauner, Dec. 9, 1986 Tr. 51).

| | | | |
|---|---|---|---|
| | Labor: $104/hr x 80 hours | | $ 8,320.00 |
| | Payroll Taxes & Ins. - $8,320 x .3476 | | 2,892.03 |
| | | (A) | $11,212.03 |
| Equipment:[21] | $517.10/day x 10 days | | $ 5,171.00 |
| | (SHA Exh. 357, p. 48) | | |

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where the MEN Formula was already required by the contract for driving concrete test piles. There was some confusion in the specifications as to the correct formula for driving steel piles. SHA decided that the contract required the use of the SEN Formula when driving steel piles with an underwater hammer.

[21] We use SHA's equipment rates as the appropriate rates based on the evidence of record.

| | |
|---|---|
| Maintenance - 37% x $5171.00 | 1,913.27 |
| Fuel Cost - $613.42/day x 10 days | 6,134.20 |
| (SHA Exh. 357, p. 58)(B) | $13,218.47 |
| Total (A)+(B) | $24,430.50 |
| Profit (10%) | 2,443.05 |
| | $26,873.55 |
| Bond (.3%) | 80.62 |
| Equitable Adjustment - 14" | |
| Steel Test Piles - Bid Item 404 | $26,954.17 |
| (Pier 13 and Pier 14) | |

14" Steel Production Piles - Pier 13 and Pier 14 - Bid Item 403.

Appellant is entitled to an equitable adjustment for the noncritical impact delay for driving of piles that were abandoned, for pulling of piles that did not reach bearing, for inleads splicing of piles where piling drove to bearing at excessive depths, for excessively long cutoffs of piles that reached bearing at shallower elevations than anticipated, and for the cumulative impacts of these activities on Appellant's performance of the pile driving work.

Pier 13

We have found that Appellant encountered a differing site condition at Pier 13. SHA's expert agreed. He recognized the time needed for cutting off piles, the time needed to drive piles that were abandoned because they did not reach bearing, and the extra time needed to drive longer piles than could be anticipated from review of the contract plans. In this regard the

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contract bid quantity for the 14" steel production piles for both Piers 13 and 14 was 12,450 linear feet. Appellant actually drove 17,520 linear feet of piling, a 141% increase in quantity. (SHA Exh. 392-86/24;36/1).

Appellant reasonably should have been able to drive at the rate of 6 piles per day for the 14" steel production piles for a total driving time for the 92 piles involved of approximately 16 days. However, the actual pile driving time for Pier 13 was 27 work days for an overrun of 11 days. There were no inlead splices at Pier 13, but there were cutoffs ranging from one foot to twenty feet in length.

At Pier 13 Appellant generally drove the production piles uniformly and consistently across the pier using production pile length sizes that were based on the elevations at which the test piles achieved bearing, although the production piles drove to bearing at elevations well below the contract's estimated tip elevation (i.e., at elevations ranging from the estimated tip elevation of -80' to elevations ranging from approximately 10 to 20 feet below the estimated tip elevation). These piles also generally attained bearing at elevations that were at depths somewhat shallower than indicated by the elevations at which the test piles achieved bearing, except in the middle of the pier where a considerable number of production piles drove to bearing anywhere from an elevation of -82' to -125', a difference of 43 feet.

We find Appellant's time impact for the differing site condition at Pier 13 was 3 workdays. The remaining delay is attributable to Appellant for equipment breakdowns, Appellant's form work problems etc., and for its failure to prove that the additional time is attributable to SHA, as is its responsibility under this appeal.

Pier 14

Appellant took 35 actual days (40 days minus 5 days for equipment problems) to drive this piling due to the vagarious driving conditions encountered at this pier. (Tr. 4-81/22). As we found and as SHA conceded, a subsurface strata or shelf exists on one side of the location of Pier 14 that does not exist on the other. The result is that in most cases the piles driven on one side of Pier 14 drove to bearing at elevations approximately 171% (compare -180' to -105') deeper than the bearing elevations attained on the other side of the pier. (Appellant's Exh. 248). In this regard, 51 of the production piles actually driven were approximately 160 feet in length or longer. The SHA engineer's estimate of the length of pile at the time of contract award was 80 feet based on an estimated tip elevation of -105' and the cutoff elevation of -25' (below mean low water). Also, test pile elevation depths at Pier 14 varied by as much as 69 feet among the four test piles driven. (Tr. 11-30/23, 82/3; App. Exh. 1003-26/14; Tr. 11-87/23, 88/4, 88/10, 88/15, 88/23; Tr. 11-148/12, 121/9; Tr. 3-84/3, 97/20; Tr. 11-149/1, 149/20; App. Exh. 172).

At Pier 14 the noncritical impact delay was caused by the material variability in the subsurface soil conditions across the pier location. This subsurface condition significantly affected pile driving conditions. Appellant had to deal with inleads splicing and cutoffs on a daily basis. It had to deal continuously with the question of whether to splice additional piling onto a pile when the pile had not reached bearing at the time the top of the pile being driven was near the waterline but still had a driving distance of twenty-five feet below the water to the cutoff elevation of -25'.

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As Appellant continued to drive piles at this pier, it could never determine on a consistent basis what length of pile would be required. Some piles would achieve the required blowcount (bearing) at a high elevation and some at a low elevation. For example, Pile No. 61 achieved bearing at a tip elevation of -120' and Pile No. 38 reached bearing at a tip elevation of -181', a 61 foot difference in pile depths although the two piles were only eight feet apart. However, Appellant reasonably should have expected only a 10 foot variation in elevations at which bearing would be attained across the Pier 14 location. The result of the above described conditions was disruption to the 14" steel production pile driving operation at Pier 14 which resulted in an increase in costs above those covered by Appellant's unit prices for driving the steel production piles. (App. Exh. 1003-62/3; App. Exh. 247; Tr. 3-94/7, 11-144, 6-166/25, 6-167/4, 6-167/8; SHA Exh. 392-86/24, 87/16; Tr. 18-117/25, 149/2, 249/16; App. Exh. 297; Tr. 10-18/2, 19/1; App. Exh. 1001A-65/8).

Appellant reasonably anticipated driving 92 steel production piles at Pier 14 in 16 days based on a reasonable pile driving rate of 6 piles per day. Appellant contends it took 35 days to drive these piles for a variance of 19 noncritical impact delay days, if its equipment breakdown problems are excluded. Appellant's delay analysis expert, however, calculated 18 days of noncritical delay.

SHA, on the other hand, believes Appellant incurred up to 17 days of noncritical impact delay in the work including 10.3125 days for splicing piles in the leads, and cutoff delays. (SHA Brief, pp. 144-45). SHA's conclusion is based in part on a detailed analysis of how long it took Appellant to complete 55 splices that were required due to the unanticipated deep driving

of piling. SHA's expert's analysis of the noncritical impact delay of 17 days is consistent with Appellant's expert's analysis of this time. (SHA Exh. 392, pp. 56, 92-94, Trauner).

We find Appellant's noncritical delay at Pier 14 was for 17 days including the time required for pile splicing, pile cutoffs, driving longer piles than anticipated, pulling piles, and driving piles that were later abandoned. The delay at Pier 14 when combined with the 3 day delay at Pier 13 yields a total of 20 days of noncritical delay as follows.

Pier 13 - 3 WD days, noncritical delay (SHA Exh. 392, p. 87)

Pier 14 - 17 WD noncritical delay (SHA Exh. 392, p. 87,Trauner)

Total 20 WD noncritical delay

However, SHA's calculations rather than Appellant's more accurately reflect based on the record the cost impact of the additional work Appellant performed based on the actual, additional work required due to the differing site conditions. Accordingly, our method of determining Appellant's equitable adjustment is based on SHA's method of calculating Appellant's equitable adjustment coupled with application of the jury verdict method.

Abandoned Piles at $30.00 per linear foot - unit price

| | |
|---|---|
| Pier 13 - Pile Nos. 11, 19, 33A, 35A & 36; 470.4 L.F. of additional piling (SHA-RFF (SHA Proposed Finding of Fact 196.01 & SHA Exh. 367) 470.4 L.F. x $30/L.F. | $ 14,112.00 |
| Pier 14 - Pile Nos. 1, 5, 8; 351.5 L.F. of additional piling (SHA-RFF 214.04 & SHA Exh. 367) 351.5 L.F. x $30/L.F. | 10,545.00 |
| Subtotal (A) | $ 24,657.00 |

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|---|---|
| **Extra Work - Splicing** | |
| Pier 13 - none | |
| Pier 14 - 55 splices at 2.0 hours per splice (Appellant AFF 210 (Appellant's Proposed Finding of Fact; Appellant's Brief, p. 92; App. Exh. 1001A-66/7.) (SHA - RFF 150) = 110 hours or 13.75 days | |
| Crew Cost - Pier 14: 13.75 days x $1,146/day | $15,757.50 |
| Payroll Taxes & Insurance $15,757.52 x .3476 | 4,107.98 |
| Subtotal (B) | $ 21,234.81 |
| **Equipment** | |
| Pier 14 - 13.75 days (SHA Exh. 357. p. 62) x $457.68 per day | 6,293.10 |
| Maintenance (37%) | 2,328.45 |
| Fuel (SHA Exh. R357, p. 59 - adjusted) | 2,372.18 |
| Subtotal (C) | $ 10,993.73 |
| **Excess Material** (RFF 214.05) (credit for material length of abandoned piles 821.9 L.F.)[22] 821.9 L.F. X 89 lbs per L.F. = 73,149.1 lbs. at $19.70 per 100 lbs. | $ 31,217.58 ($ 14,410.37) |
| Subtotal (D) | $ 16,807.21 |
| Subtotal (B) +(C)+(D) | $ 49,035.75 |
| Markup (10%) | 4,903.58 |
| Total Extra Work | $ 53,939.33 |
| + Abandoned Piles (A) | 24,657.00 |
| | $ 78,596.33 |
| Bond (.3%) | 235.79 |
| Equitable Adjustment 14" Steel Production Piles - Piers 13 and 14 | |
| Total | $78,832.12 |

**Summary of Appellant's Equitable Adjustment**

[22]Since the unit price includes the cost of the material in excess material usage calculated by Mr. Trauner, this must be deducted.

| | |
|---|---|
| I. Wave Equation | No Entitlement |
| II. Load Test-Pier 9 | No Entitlement |
| III. 18 Inch Concrete Test Piles | $ 25,782.13 |
| IV. 18 Inch Concrete Production Piles | 57,371.97 |
| V. 14 Inch Steel Test Piles | 26,954.17 |
| VI. 14 Inch Steel Production Piles | 78,832.12 |
| Equitable Adjustment : | $188,940.39 |

Predecision Interest

Md. Ann. Code, State Finance and Procurement Article §15-222, entitled "Interest" provides as follows:

> (a) Award - Authorized. - Notwithstanding any provision of a procurement contract, the Appeals Board may award interest on money that the Appeals Board determines to be due to the contractor under a contract claim.
>
> (b) Same - Accrual. - (1) Subject to paragraph (2) of this subsection, interest may accrue from a day that the Appeals Board determines to be fair and reasonable after hearing all the facts until the day of the decision by the Appeals Board.

* * *

Appellant's claim was complex and involved detailed analysis of hundreds of documents by the parties and their experts during the course of submittal of the claim to SHA and during the course of this appeal. However, we believe the parties were reasonably knowledgeable concerning the technical, legal, and cost aspects of Appellant's claim at the time the agency issued the

final decision denying the claim in its entirety. Pursuant to our discretion under §15-222, we thus have fixed the date for commencement of predecision interest that we find to be fair and reasonable based on the record in this appeal to be the date of the Administrator's Final Decision. Appellant thus shall accrue predecision interest on its claim from June 10, 1985, the date of the Administrator's Final Decision denying Appellant's claim, to the date of this decision. (Administrator's Final Decision Rule 4, Tab II). However, pursuant to Appellant's agreement, we find that that interest shall not accrue for the period from April 15, 1987 to July 29, 1987.

Retainage:

SHA held $25,000 of Appellant's money due under the contract as retainage from November 12, 1983 (the date of Appellant's invoice) to February 26, 1987 when SHA returned all but $1000 of the retainage to Appellant. However, SHA still holds $1000 as retainage under the contract. Appellant is entitled to interest at the rate of 10% on the contract amounts SHA held as retainage ($25,000) and on the amount it continues to hold as retainage ($1000) based on the days held determined as follows:

Retainage Days

| | | ($24,000) | ($1,000) |
|---|---|---|---|
| 1983 | November 12 -December 31 | 49 | 49 |
| 1984 | | 366 | 366 |
| 1985 | | 365 | 365 |
| 1986 | | 365 | 365 |
| 1987 | (January 1 to February 26) | 57 | |
| 1987 | (delete April 15 to July 29) | | 260 |
| 1988 | | | 366 |

1989 (January 1 to Date of Decision) ___ Days in 1989

1202 Total Retainage Days

In addition, Appellant shall accrue interest on the award under the Appeals Board decision from the date of the decision until the day on which the award is paid pursuant to Md. Ann. Code State Finance and Procurement Article §15-222(c).

For the foregoing reasons, therefore, the appeal is sustained in the amount of the equitable adjustment stated.

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## APPENDIX A

## PRECAST PRESTRESSED CONCRETE PILES

Included:

This work shall include the manufacturing, furnishing, fabricating, handling, driving, installing test piles, cutting off and performing pile load tests of the precast prestressed concrete piles shown on the Plans and as described herein

* * *

Section 34.05-3 of the Specifications is amended to add:

* * *

The equipment for driving precast prestressed concrete piles shall conform to the Specifications except that pile driving hammers shall be steam or air operated only and develop driving energies not less than the following:

| Square Dimension of Pile | Minimum Hammer Energy |
|---|---|
| 18" | 40,000 ft.-lbs./blow |
| 12" | 25,000 ft.-lbs./blow |

Approximate elevations of pile tips shown on the Plans have been estimated from boring information, but are not to be considered final. It will be the Contractors responsibility to determine the pile lengths from test piles.

All piles shall be driven to the minimum safe bearing value shown on the Plans and must penetrate to the minimum tip elevations shown on the Plans or as otherwise indicated by the results of the pile load tests, all as directed by the Engineer. The Engineer shall be the sole judge as to what constitutes a satisfactory penetration of the pile into original ground.

Piles shall be driven to a tip elevation approximately the same as the nearest test pile and as much deeper as necessary to develop the required safe bearing capacity as indicated by the pile driving formula.

The hammer to be used for driving permanent piles shall be the same hammer that was used to drive the test piles. If the Contractor changes hammers, he must drive additional test piles at his expense before driving the permanent piles even if the energy ratings of the hammers are identical.

Jetting or pre-drilling of piles will be permitted by the Engineer only after receipt and approval of the Contractor's proposed methods.

The heads of the piles shall be cushioned during driving by approved cushion blocks consisting of several plies of wood or other approved material. During driving the reduction in thickness of the cushion block shall be limited to 25% of the original thickness.

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The Contractor shall size the complete pile-hammer system by a suitable wave equation analysis for the various subsurface conditions to be encountered on the project in order to prevent over-stressing the piles and submit the analyses to the Engineer prior to any driving.

Piles shall be held in fixed leads during driving. The intent of these Special Provisions is that the leads support and the hammer follow the pile throughout the entire length of driving.

No field splices will be permitted in any pile unless specifically approved by the Engineer in writing.

The Contractor shall furnish the Engineer schedules of the driving sequence he proposes to use at piers and the south abutment, and driving shall not be started at any pier or abutment until the schedule for the location has been approved. Departures from these schedules shall not be made without the Engineer's approval.

Section 34.05-3 Paragraph 7 - Determination of Bearing Value will be modified to:

$$P = \frac{2WH}{S + 0.1\frac{(WP)}{(WR)}}$$ for single acting power hammer

$$P = \frac{2E}{S + 0.1\frac{(WP)}{(WR)}}$$ for double acting power hammer

where: P = Safe bearing power in pounds

W = Weight in pounds of striking parts of hammer

H = Height of fall in feet

S = Average penetration in inches per blow for the last several inches of penetration.

WP = Weight of pile and follower combination.

WR = Weight of Ram

E = Approved hammer energy per blow in foot-pounds for double acting, and differential acting hammers.

The ratio of $\frac{WP}{WR}$ for the purpose of computations, shall be not less than 1.0.[23]

[23]This factor modifies the Standard Engineering News Record Formula (SEN Formula) to the Modified Engineering News Record Formula (MEN Formula).

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For battered piles the decreased energy due to the inclination of the pile driving hammer shall be used in determination of bearing value.

Test piles shall be driven in permanent vertical pile locations as indicated on the Plans, and/or as directed by the Engineer. Test piles found satisfactory shall be utilized as permanent piles.

After the test piles have penetrated to the minimum tip elevation and/or have been driven to the minimum safe bearing value shown on the Plans, load tests shall be performed on those piles so designated on the Plans or as directed by the Engineer in writing.

Test Loading

Test loadings of 200 tons shall be performed on certain of the test piles as noted on the Plans. The top of the test pile to receive the test load shall be 5 feet (minimum) above the mean high water. The test load shall be applied to the top of the pile at this elevation.

The Contractor shall furnish the Engineer with adequate facilities for confirming load and settlement readings 24 hours per day including lighting and shelter from rain, wind, and direct sunlight in the area of the instrumentation beam.

Test loading shall be performed in accordance with the applicable provisions of Section 34.05-3 of the Specifications except as modified herein and by the applicable provisions of ASTM D1143.

* * *

Method of Measurement and Basis of Payment:

Refer to the Specifications and the following:

Payment for pile load tests, authorized by the Engineer in writing, will be paid for at the contract unit price bid per each for pertinent Pile Load Test Item.

A test pile driven in a permanent pile location and if approved by the Engineer, may be used as a permanent pile, but shall only be paid for as a test pile.

No payment will be made for any field splice or buildup in test or permanent piles.

[Contract Special Provisions, pages 78-82.]

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7. Determination of Bearing Value

As previously mentioned, it is of extreme importance to the State to know the safe bearing value of the pile contemplated by the plans. Usually, test piles are provided for by the contract and to the piles so designated will be subjected

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to such tests so as to obtain reasonable reliable data. The determination of the bearing value will be primarily obtained from observation and reporting of the behavior of the test pile from the time first placed in the leads until it attains practical refusal or reaches a stratum designated by the plans or set forth by the Engineer. To furnish the Engineer and Contractor with a guide as to the probable supporting value at each position, the Engineer will compute the safe bearing value from the following formula:

$P = \frac{2WH}{S+1.0}$ for gravity drop hammers,

$P = \frac{2WH}{S+0.1}$ for single acting power hammers,

$P = \frac{2E}{S+0.1}$ Double acting power hammers

where P=safe bearing power in pounds,
W=weight in poinds of striking parts of hammer,
H=height of fall in feet,
E=approved hammer energy per blow in foot-pounds for double-acting, differential-acting and disel hammers,
S=the average penetration in inches per blow for the last several inches of penetration.

The foregoing formulas are applicable only when:
(a) The hammer has a free fall in the case of gravity drop hammer,
(b) the hammer is operating properly and at the manufacturer's recommended speed in the case of a power hammer,
(c) The head of the pile is not broomed or crushed,
(d) The penetration is reasonably quick and uniform,
(e) There is no sensible bounce after the blow,
(f) A follower is not used.
Twice the height of the bounce shall be deducted from "H" to determine its value in the formula.

If the contract does not provide for test loading, the results of the aforesaid formula as applied to the test piles will be used to designate the penetration or lengths of piles. If, however, the project does provide for test loading the results obtained as aforesaid will be held in abeyance until the specified test loads are applied. . .

[Contract General Provisions, pages 310-311 (State of Maryland, State Roads Commission, Baltimore, Maryland, Specifications for Materials, Highways, Bridges and Incidental Structures (March 1968; 2nd Ed.))("Blue Book")].

4. Required or Anticipated Length of Piling.

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The depth of penetration of the length of piling for a project or a part of the project will generally be determined by driving test piles. As a design is based upon the assumption of each pile or group of piles being capable of safely and permanently supporting the assumed design load, it is extremely important that the actual safe bearing value of piling is known. As a general rule, subsurface exploration and drive tests will give the designer a clue as to probable length of piles which will allow the required safe bearing value. Also as a general rule, the Plans or Special Provisions will indicate certain minimum lengths, penetrations or tip elevations desired. From this information the Contractor shall order and drive the test piling. The actual safe bearing value of the test piling can then be determined by methods subsequently described. Then from the test pile data and behavior, the Contractor shall order the permanent or remainder of the piling required to complete the contract, all of which is subject to the Engineer's approval.

The provisions of the previous paragraph, while applying primarily to the so-called bearing piles, also apply to pile supporting bulkheads, fenders and jetties. Although the methods for testing bulkheads, piles, and sheet piling may differ from bearing piles, acceptable lengths must still usually be calculated from test piles.

* * *

[Contract General Provisions, § 34.05-3(4), page 306.]

* * *

102.03 INTERPRETATION OF QUANTITIES IN BID SCHEDULE. The quantities appearing in the prepared Bid schedule are approximate only and are prepared for the canvassing of Bids. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the Contract. It is understood that the scheduled quantities of work to be done and materials to be furnished may each be increased, diminished or omitted without in any way invalidating prices bid, except as hereinafter provided.

102.04 SITE INVESTIGATION. The Contractor acknowledges that he has investigated and satisfied himself as to the conditions affecting the work, including but not restricted to those bearing upon transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads and uncertainties of weather, river stages, tides or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during prosecution of the work. The Contractor further acknowledges that he has satisfied himself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory



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work done by the Administration, as well as from information presented by the drawings and specifications made a part of this Contract. Any failure by the Contractor to acquaint himself with the available information will not relieve him from responsibility for estimating properly the difficulty or cost of successfully performing the work. The Administration assumes no responsibility for any conclusions or interpretations made by the Contractor on the basis of the information made available by the Administration.

[Contract Special Provisions, pages 160-61].

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