

Highway Embankment Contract Specifications

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Abstract: This four-year project was extremely successful and well executed, even though a number of changed conditions developed during the project. Of these changed conditions, only one resulted in a claim that is discussed herein. This claim involved responsibility for repairing a failed 7-m-high embankment that was widened as part of the contract. This paper discusses the slope movement mechanism, presents the relevant contract provisions and State of Ohio Construction and Material Specifications (C&MS), summarizes the various contract interpretations that developed, and the recommendation of the Dispute Resolution Board (DRB) to resolve this claim. Based on the case study, recommendations for clarifying project plans and specifications for future embankment construction are also presented. DOI: [10.1061/\(ASCE\)LA.1943-4170.0000136](https://doi.org/10.1061/(ASCE)LA.1943-4170.0000136). © 2013 American Society of Civil Engineers.

Author keywords: Contracts; Liability; Construction defect; Slope failure; Soil mechanics; Subsurface investigation; Roadway embankment.

Introduction

This paper presents a case study of contract interpretation for highway embankment widening and recommendations for clarifying project plans and specifications for future embankment construction. In general, this large project, with a bid price of about \$70 million, was extremely successful and well executed by the contractor, even though a number of changed conditions developed during the project. All of the changed conditions were negotiated successfully at the project level, except one that resulted in the claim discussed in this paper. This success is a testament to the excellent rapport developed among the contractor, owner, and the Dispute Resolution Board (DRB) created for the project. The three-member DRB was convened at the start of the project and met at the site every quarter to review the project and receive a project update from both the owner and the contractor. Some of the changed conditions that were negotiated successfully without involvement of the DRB include the following:

- Most of the bridge pilings were driven significantly deeper than designed to develop the required bearing capacity.
- The embankment for an off-ramp on a new location from Interstate-76 (I-76) Westbound to Interstate-71 (I-71) Southbound experienced a global or foundation slope failure during construction, even though the embankment construction

rate was controlled by allowable pore water pressure changes. Prefabricated vertical strip drains were installed to dissipate the pore water pressure and accelerate consolidation of the underlying native soils.

- Construction of a 274.5-m-long concrete bridge structure to replace the proposed soil embankment described here because of uncertainties with rebuilding the embankment on the weak native soils in the vicinity of a preexisting stream and the prior slope failure.
 - Project resequencing and additional traffic maintenance costs to mitigate the delays associated with the design and construction of the new 274.5-m-long off-ramp bridge.
 - Cement stabilization of the mainline I-71 subgrade.
- A three-tier dispute resolution ladder was used for the project:
- Tier 1: Negotiation and resolution at the project level by the project engineer and the contractor's project manager.
 - Tier 2: Negotiation and resolution at the owner level with high-level owner and contractor representatives.
 - Tier 3: A hearing with presentations by both parties to the DRB and a ruling on the merits and amount of damages by the DRB.

Even with the significant changed conditions described here and the associated negotiations, the project was completed successfully by the original completion date in July 2010. This paper discusses the slope failure in the I-71 Southbound roadway embankment between Stations 420 + 80 and 421 + 80 LT that resulted in the only DRB hearing and ruling. For clarity, this is a different embankment slope failure than the off-ramp embankment from I-76 Westbound to I-71 Southbound described previously.

Project Description

This project involves the widening and reconstruction of 5.15 km of U.S. I-71 at the U.S. I-76 interchange near Lodi, Ohio, which took place from 2006 to 2010. This project included the addition of a third lane for both northbound and southbound traffic on I-71, subgrade stabilization on I-71, installation of prefabricated vertical drains to accelerate subsoil consolidation to about six months for approach embankment construction, widening of about 5.15 km of

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Note. This manuscript was submitted on May 31, 2013; approved on August 7, 2013; published online on August 10, 2013. Discussion period open until May 16, 2014; separate discussions must be submitted for individual papers. This paper is part of the *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, © ASCE, ISSN 1943-4162/05013002(7)/\$25.00.

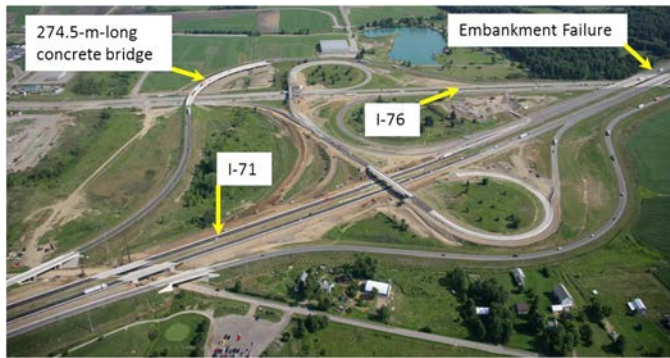


Fig. 1. Aerial view of project during the last year of construction showing a 274.5-m-long concrete off-ramp bridge from I-76 Westbound to I-71 Southbound and I-71 Southbound embankment failure location (photograph used with permission from ODOT)

I-71, construction of new off-ramps and embankments on new alignments, and demolition and reconstruction of 13 bridge structures. The plans and specifications for this project were started in 2003 and completed in 2004. The project was bid on August 23, 2006, and awarded by the Ohio Department of Transportation (ODOT) on August 31, 2006, for \$70,409,994. With change orders of about \$6,641,384 million, the total cost of the project was \$77,051,379. Fig. 1 presents an aerial view of the project during the last year of construction. Two important features shown in Fig. 1 are (1) the 274.5-m-long concrete bridge that replaced the off-ramp embankment from I-76 Westbound to I-71 Southbound described previously, which was not involved in the DRB hearing; and (2) the embankment failure on southbound I-71 between Stations 420 + 80 and 421 + 80 LT, near the upper-right corner of the photograph and labeled “Embankment failure,” which is the subject of this paper.

Embankment History, Description, and Widening

This section of I-71 was initially constructed circa 1961, with 2:1 embankment slopes. However, at some later point, the outside

slopes in the vicinity of Stations 422 + 00 to 423 + 00 were flattened to approximately 2.5:1, possibly by ODOT maintenance forces. It appears now that some of this embankment work was uncontrolled, while it incorporated some organic materials and soft clays into the embankment, and without employing proper benching techniques. This created a weak interface at this embankment location. Other than the final slope geometry, the designer was unaware of the later embankment work. This undetected, weak interface was a contributing factor of the slope failure described next.

Figs. 2 and 3 present the contract drawing for the widening of the I-71 embankment at Stations 422 + 00 and 423 + 00, respectively. These two drawings illustrate the sliver fill required to widen I-71 Southbound between Stations 420 + 80 and 421 + 80 LT. These diagrams show that the new fill should be benched into the existing embankment to create the new 2H:1V slope on the west side of the embankment.

In September and October 2008, the contractor widened the existing 7-m-high embankment at the northern approach to the I-71 Southbound bridge over I-76, as shown in Fig. 4. By March 2009, about a 30-m length of the embankment started showing signs of down-slope movement (see Fig. 5 for the location of the slope movement). This movement continued and enlarged. Fig. 6 shows the movement on August 31, 2009, which corresponds to one of the quarterly site visits of the DRB. The slope movement was discussed during the prior quarterly DRB meeting but was not of great concern at that time. During the August 31, 2009, meeting, the owner and contractor expressed concern about the slope movement.

Contract Requirements for Slope Benching

The different contract interpretations for this embankment construction, which were used to develop recommendations for better contract documents and diagrams for future highway embankment widening projects, are presented in this section. The main contract interpretation issue was which benching specification the contractor had to follow for the slope between Station 420 + 80 and 421 + 80 LT on I-71 Southbound.

The contractor understood that the embankment benching requirements in the contract were governed by the State of

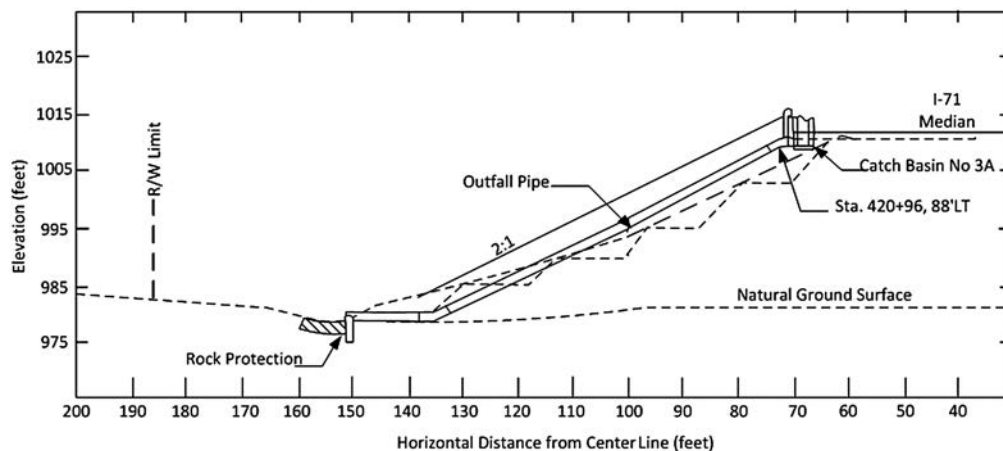


Fig. 2. Plan drawing for I-71 Southbound embankment from Station 420 + 00 to Station 421 + 00 showing sliver fill for lane widening on I-71 Southbound on ODOT Construction Sheet 254 of 1120 (adapted from State of Ohio 2004)

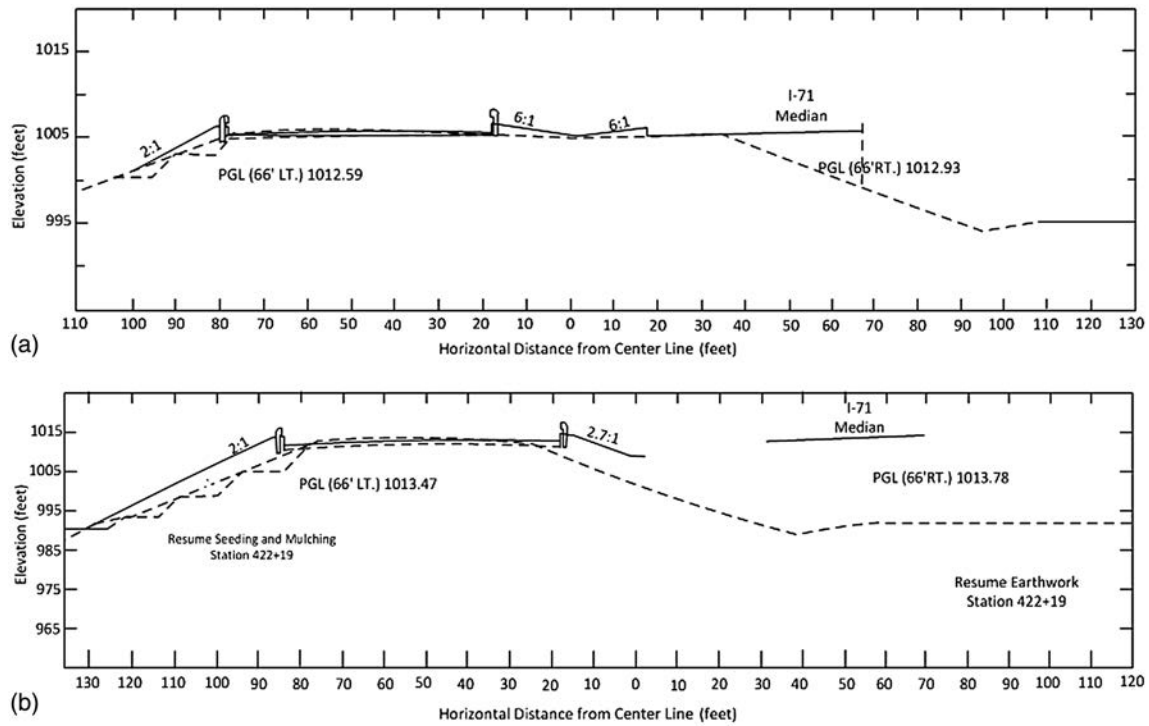


Fig. 3. Plan drawing for I-71 Southbound embankment at (a) Station 422 + 00; (b) Station 423 + 00, showing sliver fill for lane widening on I-71 Southbound on ODOT Construction Sheet 255 of 1120 (adapted from State of Ohio 2004)



Fig. 4. Construction of sliver fill for lane widening on I-71 Southbound between Stations 420 + 80 and 421 + 80 LT looking (a) southbound with I-76 in the foreground; photograph used with permission from Ruhlin Company; (b) northbound along I-71 (photograph used with permission from ODOT)

Ohio Construction and Material Specifications (C&MS) Section No. 203.05 (State of Ohio 2005). The contractor maintained that ODOT knew the benching was constructed per the C&MS and did not object. C&MS Section No. 203.05 states:

If the existing slope is steeper than 8:1, bench into the existing slope as follows:

1. Scalp the existing slope according to Item 201.
2. Cut horizontal benches in the existing slope to a sufficient width to blend the new embankment with the existing embankment and to accommodate the placement, and compaction operations and equipment. (Bold added to original.)
3. Bench the slope as the embankment is placed, and compact into layers.
4. Begin each bench at the intersection of the existing slope and the vertical cut of the previous bench. Recompact the cut materials along with the new embankment.

C&MS 203.05 allows the contractor discretion in determining the benching limits; it is not at all specific. However, the Construction Plan Sheets for this embankment area [i.e., Plan Sheets 254 (Sta. 420 + 00 to 421 + 00, shown in Fig. 2) and 255 (Sta. 422 + 00 to 423 + 00, shown in Fig. 3 from ODOT (State of Ohio 2004))] also show a “Typical Benching” detail that probably resulted in some confusion. The “Typical Benching” detail shown on these two Plan Sheets is presented in Fig. 7 and has the following note:

“Benching illustrated to show obvious locations requiring benching. See note on sheet 32. No waiver of the specifications is implied at locations where benching is not shown.”

The Plan Sheets on Sheet 32 referenced in the Typical Benching Detail [shown in Fig. 7 in ODOT (State of Ohio 2004)] states:



Fig. 5. Aerial view of I-71 Southbound between Stations 420 + 80 and 421 + 80 LT with I-76 crossing below it after remedial measures; circle shows the area prior to subject slope movement (photograph used with permission from ODOT)

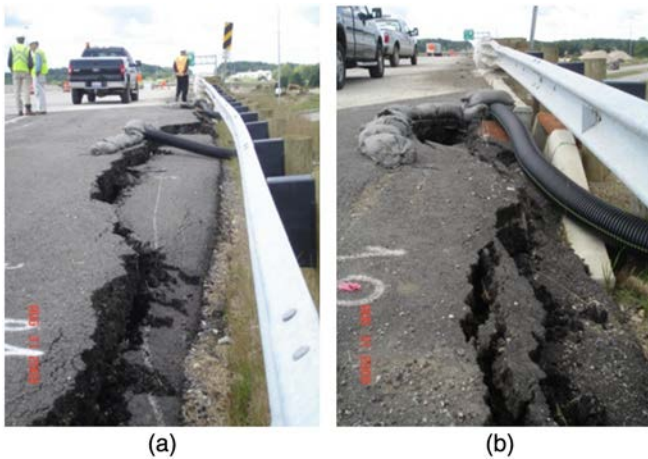


Fig. 6. (a) Overview of distress at the top of the new embankment on I-71 Southbound between Stations 420 + 80 and 421 + 80 LT; (b) close-up of pavement distress and damage to storm water Catch Basin No. 3A (photographs by T. D. Stark)

Benching of Foundation Slopes:

Although cross sections indicate specific dimensions for proposed benching of the embankment foundations in certain areas, **no waiver of the specifications is intended.** All other sloped embankment areas shall be benched as set forth in 203.05. No additional payment will be made for benching required under the provisions of 203.05. (Bold added to original.)

This plan note resulted in two different interpretations of how the slope between Stations 420 + 80 and 421 + 80 LT on I-71 Southbound should be benched and widened. The following sections of this paper detail the contractor's and owner's interpretations of these contract provisions.

Contractor's Interpretation

The contractor believed that the owner should pay for the remedial measures required to reconstruct the embankment area shown in

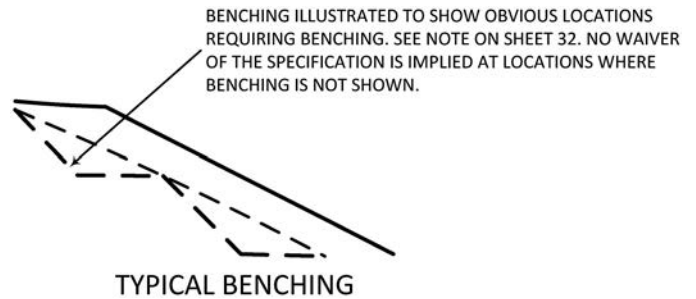


Fig. 7. Typical Benchng Detail from ODOT Construction Plan Sheets 254 and 255 of 1120 (adapted from State of Ohio 2004)

Fig. 6 and filed an initial claim of \$149,024 to repair the slope movement. This section presents the contractor's interpretation of the Note on Plan Sheet 32, the Typical Benchng Detail on Plan Sheets 254 and 255, and C&MS 203.05 as presented previously.

The contractor believed the Note on Plan Sheet 32 (*State of Ohio 2004*) means that although specific dimensions for slope benchng and construction are illustrated on Sheets 254 and 255, no waiver of the benchng specification (C&MS 203.05) is intended. Therefore, even though benchng is illustrated in scaled cross sections on Plan Sheets 254 (see Fig. 2) and 255 (see Fig. 3), slope benchng and construction must be performed in accordance with C&MS 203.05, with which the contractor complied.

The contractor further believed that the scaled cross sections on Plan Sheets 254 and 255 (*State of Ohio 2004*) did not provide sufficiently detailed "specific dimensions" to construct the benchng and new slope. In particular, the contractor believed that the use of dashed lines on scaled cross sections (see Figs. 2 and 3) are not proper to describe the depth and location of benchng to be performed because dashed lines are typically used to portray existing conditions. Finally, the contractor stated that typical ODOT design protocol would include pay quantities for both the benchng excavation quantity and embankment quantity if it intended for this work to be performed, and interpreted a lack of pay quantities for excavation and benchng on the cross sections to mean that slope benchng and construction were to be performed per C&MS 203.05. This is because this work was expressly included in its bid price.

In summary, the contractor maintained that because the plan cross sections did not show detailed benchng elevations, widths, and slope information, it was required to use the discretion afforded in C&MS 203.05 to construct the embankment. The DRB considered this to be a reasonable interpretation of the slope benchng and construction requirements.

Owner's Interpretation

This section presents the owner's interpretation of the cross sections on Sheets 254 and 255, Note on Plan Sheet 32, Typical Benchng Detail, and C&MS 203.05.

The owner believes that the Note on Plan Sheet 32 (*State of Ohio 2004*) indicates that in areas where specific dimensions for benchng are provided on the plan sheets, these specific dimensions must be followed. This is reinforced by the next sentence of the Note, which states: "All other sloped embankment areas shall be benched as set forth in 203.05."

In addition, the owner believed that the scaled cross sections on Plan Sheets 254 and 255 (*State of Ohio 2004*) provided specific dimensions sufficient to construct the new slope, because the solid

and dashed lines shown on these cross-section sheets have accurate horizontal and vertical scales that correspond to field conditions. For example, one set of dashed lines shows the exact location and depth of benching at that particular station (see Figs. 2 and 3). Finally, the Note on Plan Sheet 32, which states that “no waiver of the Specifications is intended,” means that if the cross sections are silent on an aspect of the benching (e.g., slope scalping), the requirements of C&MS 203.05 are not waived.

The owner also assumed that lack of pay quantities in the contract documents for benching in the relevant cross sections was an oversight. However, the owner understood that this oversight could be remedied by the general contract provision that allows for revising the plan quantities for excavation and embankment.

Finally, the owner stated that many ODOT contracts have been awarded that require routine slope benching per C&MS 203.05 by default and without mention. As a result, if the owner wanted to require only routine slope benching per C&MS 203.05, the Plan Sheets would have been silent on the matter and not have included the additional notes and cross-section details.

DRB's Analysis

This section presents the DRB's analysis of the slope benching requirements set forth in the cross sections on Sheets 254 and 255, Note on Plan Sheet 32, Typical Benching Detail, C&MS 203.05, and the ruling issued by the DRB to resolve the dispute. The main issue for the DRB to address was:

What benching detail was required by the contract for the slope between Station 420 + 80 and 421 + 80 LT on southbound I-71?

The contract provided the following hierarchy of contract documents, which facilitated contract interpretation and determined the required benching for this embankment. C&MS 105.04 states:

“The Engineer will resolve discrepancies using the following order of precedence:

1. Addenda
2. Proposal and Special Provisions
3. **Plans**
4. Supplemental Specifications
5. Standard Construction Drawings
6. **Standard Specifications.**” (Bold added to original.)

In summary, the contract plans (i.e., cross-section details) control the general C&MS 203.05 specifications.

Next, the DRB considered the Plan Note of Page 32, which states:

Although cross sections indicate specific dimensions for proposed benching of the embankment foundations in certain areas, **no waiver of the specifications is intended.** (Bold added to original.)

This Plan Note can be interpreted to mean that if the plans show “specific dimensions” for benching, these dimensions must be followed. However, the other requirements of C&MS 203.05, which are not shown on the plans, must be followed, such as “scalp the existing slope,” “accommodate the placement, and compaction operations and equipment,” “compact into layers,” and “recompact the cut materials along with the new embankment.”

The next important consideration is whether the cross sections on Sheets 254 and 255 provide sufficient information to bench and construct the new embankment slope. Figs. 2 and 7 show the benching detail and scaled slope cross section, respectively, which appear on Construction Sheet 254. The “typical benching” schematic diagram in Fig. 7 illustrates existing grade (lighter dashed line), final slope (solid line), and benching (darker dashed line) lines to better interpret the lines of the specific cross section shown below them on the same sheet. More important, the “typical benching” diagram does not have horizontal or vertical scales, so the illustrated slope configuration cannot be constructed, whereas the scaled cross sections have accurate horizontal and vertical scales, which are sufficient to bench and construct the slope. Fig. 2 shows the scaled cross section for I-71 Southbound embankment from Station 420 + 00 to Station 421 + 00, which shows a sliver fill to widen I-71 Southbound. The cross section gives the elevations and horizontal distances from the I-71 center line, and solid and dashed lines that correspond to the natural ground surface and benching.

C&MS 203.05 states that any slope steeper than 8:1 must be benched; therefore, the contractor knew that some benching requirements were needed and benched the slope according to those specifications. In summary, every slope steeper than 8:1 must be benched in some fashion, and the subject slope is 2:1; therefore, the slope had to be benched.

Scaled cross sections are shown only at certain stations in the plan drawings, so interpolation between the cross sections must occur to construct the slopes between the scaled cross sections. For example, Sheets 254 (see Fig. 2) and 255 (see Fig. 3) show scaled cross sections for Stations 420 + 00 and 421 + 00 and Stations 422 + 00 and 423 + 00, respectively. Therefore, the contractor must interpolate the slope geometry from these cross sections at stations that are between these stations. This is a typical practice because construction plans would be even more voluminous if cross sections for every 3 m of embankment had to be included. This is anticipated by C&MS 203.08, which states:

Finish the completed excavation and embankment to the **cross-sections shown on the plans. The Engineer will allow occasional deviations in the work within the following tolerances:**

...

C. For the **backslopes (cut slopes)**, from the back of the ditch to the existing ground, and for the foreslopes (fill slopes), from the edge of the graded shoulder to the bottom of the ditch, do not allow deviations greater than 1 foot (0.3 m) as measured in the horizontal plane. (Bold added to original.)

In summary, the specifications allow some tolerance for earthwork construction because of the approximate nature of this work. In addition, C&MS 105.03 allows some tolerance from grades, cross sections, and dimensions from plans; it states:

Perform all Work and furnish all Materials **in reasonably close conformity with the lines, grades, cross-sections, dimensions,** and material requirements as shown on the Plans and as specified. (Bold added to original.)

DRB's Conclusion

This section presents the DRB's conclusion of the slope-benching requirements of the contract. The DRB concluded from the

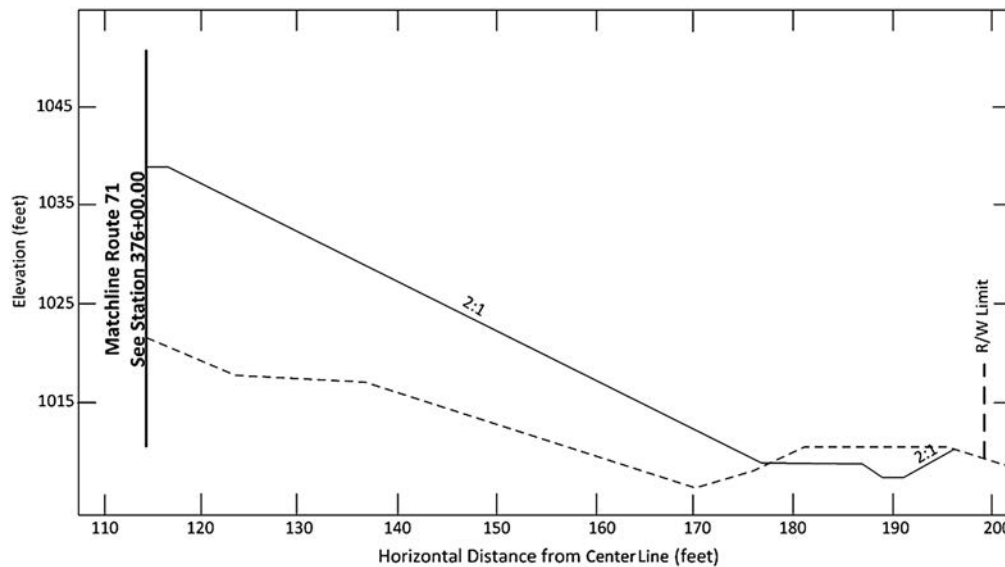


Fig. 8. Benching details from ODOT Construction Plan Sheet 227 of 1120 for Station 376 + 00 to Station 377 + 00 I-71 (adapted from State of Ohio 2004)

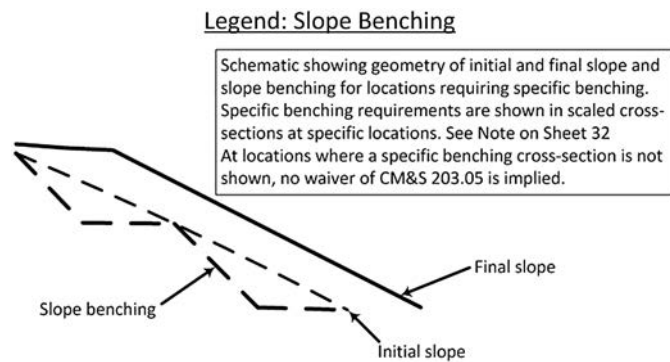


Fig. 9. Proposed legend for benching diagrams

evidence presented that the contractor used the CMS benching requirements rather than the plan cross-section benching. In addition, subsequent exploratory work revealed other subsurface factors that were not previously known by either party, which contributed to some of the damage.

The “Typical Benching” sketch on Sheet 254 of 1120 clarifies the lines shown in the station specification cross sections on Sheets 254 and 255 (Figs. 2 and 3, respectively). The accompanying note states that the cross sections show “obvious locations requiring benching,” and the Note on Plan Sheet 32 (State of Ohio 2004) should be consulted for additional directions. However, no waiver of C&MS 203.05 is implied or allowed “where benching is not shown.” Thus, if benching is not shown on a station specific cross section, the contractor must use C&MS 203.05. Such an example is illustrated in Fig. 8 for Station 376 + 00 to Station 377 + 00 on Sheet 227 of 1120 where no benching is shown, so the contractor must use only C&MS 203.05 benching to construct the final slope shown.

Sheet 254 of 1120, shown in Fig. 2, clearly indicates a cross section, or cut-fill diagram, with lines that indicate the existing slope, slope benching, and final slope grade lines, which overrides C&MS 203.05. In addition, the cross section identifies the specific station, 420 + 96, where the cross section and benching must be

applied. Thus, the cross section on Sheet 254 of 1120 is more specific than C&MS 203.05 because the cross section shows specific elevations for each bench and the width of each bench, whereas C&MS 203.05 does not. C&MS 203.05 provides no details for continuing benching from one station to another, and neither do the station-specific cross section shown on Sheets 254 and 255 of 1120 with linear interpolation between the cross sections.

The “Typical Benching” sketch on Sheet 254 of 1120 (State of Ohio 2004) also cites the Note on Plan Sheet 32 (State of Ohio 2004), so the requirements of this Note must be met, too. Sheet 32 Note states, “Although cross sections indicate **specific dimensions** for proposed benching of the embankment foundations in certain areas, no waiver of the specifications is intended.” (Bold added to original.) Therefore, the cross section must show “specific dimensions” to construct the slope benching and final slope.

The cross sections have horizontal and elevation scales that reflect current slope conditions and their relationship to the existing slope, and they can be used to construct the slope benching and final slope. A similar cross section without benching details is shown in Fig. 9 for Sheet 227 to construct the final slope and ditch at the slope toe. However, the contractor was able to use the horizontal and elevation scales on Sheet 227 and at other locations to construct a final fill slope. In summary, the cross section on Sheet 254 of 1120 provides “specific dimensions” for the benching and final slope of the embankment.

Many other plan sheets show station-specific benching outside the subject area [e.g., Sheets 278 (Sta. 457 + 00) and 279 (Sta. 458 + 00 to 459 + 00) of 1120 (State of Ohio 2004)]. If the contract did not require the contractor to use this special benching, the additional details on the cross sections would not have been included at this and other locations [e.g., Sheets 234, 235, 252 through 272, 278, and 279 of 1120].

DRB’s Damage Award

Based on these findings, the DRB reached an equitable conclusion of this small dispute by defining items for which the contractor was entitled to compensation. This section briefly presents the damages awarded by the DRB for the only claim that was not

negotiated successfully between the contractor and ODOT during this successful and on-time project.

Based on the DRB's analysis, the ruling stated that the contractor was entitled to the costs associated with constructing the initial embankment and costs to remove two isolated tree deposits that were encountered during the slope failure investigation and slope reconstruction. The DRB also concluded that the contractor was not entitled to additional compensation for removing high-moisture content material below the "special benching" required by the scaled cross sections on Plan Sheet 254 and 255 (State of Ohio 2004), because the slope failure probably allowed some water to infiltrate the embankment fill through tension cracks at the top of the slope and the damaged catch-basin (see Fig. 6) after slope movement started. The final value of the claim, as agreed to by ODOT and the contractor, was \$66,232. The initial amount of the claim was about \$150,000. The specific amounts awarded were as follows:

- Slope failure investigation \$8,974
- Excavation of unsuitable embankment fill \$28,776
- Embankment to replace unsuitable \$15,359
- Excavation of special benches \$7,150
- Embankment for special benches \$5,973

Recommendations for Contracting for Slope Benching

This section presents some recommendations for providing additional clarity to the various clauses and drawings used to contract for slope benching and embankment widening based on this case study. The first recommendation involves using a few concise and specific contract clauses to convey the contract requirements to the contractor. The inclusion of a number of clauses at various locations in the contract documents contributed to the confusion and increased the possibility of differing interpretations. As mentioned previously, these many requirements resulted in reasonable but conflicting interpretations by both parties, which created this payment dispute.

The second recommendation is to change the label of the schematic benching detail shown on Construction Plan Sheets 254 and 255 (State of Ohio 2004) to "Legend: Slope Benching," as shown in Fig. 9, instead of "Typical Benching." This should provide clarity that the lines shown in Fig. 9 are used for definition purposes only.

The third recommendation involves the Note on Plan Sheet 32 (State of Ohio 2004) referenced in Fig. 9, which could be changed to the following:

Benching of Embankment Slopes

Although scaled cross-sections indicate specific dimensions for proposed benching of the **existing embankment slopes** in certain areas, **waiver of other requirements** of the specifications is **not** intended. All other sloped embankment areas shall be benched as set forth in CM&S 203.05. No additional payment will be made

for benching required under the provisions of 203.05. (Bold indicates proposed changes.)

The changes proposed herein only relate to this contract and illustrate the ambiguity and possibility of multiple interpretations. This is based on the contractor performing benching for other ODOT projects that did not result in problems during construction. However, these recommendations should be considered for future projects to ensure that a similar dispute does not develop.

Summary

This paper presents a case study of how seemingly straightforward contract clauses can be interpreted in at least two ways. This frequently occurs because the relevant information is spread throughout the contract documents, and the language in each document may not be completely consistent with the information in another location. Other problems occur when a contractor must interpret the contract requirements when certain sections are "silent" on an issue and must refer to another location.

Recommendations are presented herein to clarify the meaning of typical slope-benching details to reduce the potential for future construction claims. This case study also provides a reminder of the following contract interpretation rules, which should be considered when interpreting potentially ambiguous contract provisions:

- Plans take precedence over specifications.
- Cross sections on plans are sufficient to define and construct slope benching in conjunction with a general specification (i.e., C&MS 203.05 in this case).
- If the benching detail is silent on an issue (e.g., existing slope must be "scalped," benching must "accommodate the placement, and compaction operations and equipment," "compact into layers," and "recompact the cut materials along with the new embankment"), the contractor should use the general contract requirements (i.e., C&MS 203.05 in this case).
- Because of the nature of earthwork construction, specifications usually allow some tolerance and deviation from the plan cross sections, may not completely delineate the entire length of the embankment, or both.
- The use of similar plan cross sections and cut and fill diagrams in construction plans for construction of final slopes and ditches in other areas of the project should indicate that they possess sufficient dimensions for slope benching and widening in other areas.

References

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