206-2 - ROCK EXCAVATION (GRADING) OPSS 206

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206-2 - ROCK EXCAVATION (GRADING) OPSS 206

206-2.1  GENERAL

This section deals with the excavation, haulage and placement of rock material, as classified by OPSS 206, and should be read in conjunction with Section B206-1 of this Chapter - "Earth Excavation (Grading)," as the computation methods and balancing of quantities apply to both.

Rock excavation in roadway cuts, including detours, utilizes a method called "wall-control blasting," which is a precise method of rock blasting that minimizes the overbreak of rock produced by standard blasting techniques, leaving a vertical rockface.

The use of wall-control blasting generates a subsidiary tender item to "Rock Excavation (Grading)" called "Rock Face", which applies in rock cuts and is measured in square metres.

The savings realized in the reduction of rock quantities offset the additional costs of precision blasting, while safety conditions are improved by the elimination of irregular walls of jagged rock.

Earth material overlying rock formations is termed "earth overburden" and treated as earth.

Weathered rock is classified as earth when drilling is not required.

On projects where there is rock blasting adjacent to existing pavement which is not listed for removal or resurfacing, it has been found that, irrespective of the type of protection employed, damage to the pavement usually resulted. Therefore, where widening of rock cuts with a height of 1.5 m or more above the roadway surface is required adjacent to existing pavement as noted above, an allowance for the resurfacing of that area of the highway exposed to falling rock will be made. See Section B313 of this Chapter for details.

206-2.1.1  Classification of Rock Materials

The following materials when encountered during grading operations usually are treated as rock, and are included in the tender item "Rock Excavation (Grading)":

(a) Solid Rock

Solid rock means natural beds of hard, cemented parts of the earth's crust (igneous, metamorphic or sedimentary in origin), which may or may not be weathered; the weathered material may be highly or only moderately
weathered, but the key is that it has not been moved from its natural bed; as identified in the Geotechnical Report and shown on the Soils Profile.

(b) Boulders

Boulders and fragmented rock measuring 1.0 m³ or larger.

(c) Shatter

Shatter is the fracturing of solid rock within the road section by the use of explosives, to form a suitable foundation to receive the granular base course, and also to provide drainage of the roadbed.

206-2.1.2 Tender Items

The tender items associated with highway grading in rock are:

1. Rock Excavation (Grading)

   and includes material from the following operations

   Rock Cut/Fill and Shatter
   - roadway
   - side ditches
   - transition points
   - sidewalks
   - widening
   - entrances

   Ditching
   - intake/offtake
   Boulders - 1.0 m³ or larger
   Watercourse Correction
   Frost Treatment, isolated
   Commercial Entrances
   Backfill Requirements

2. Rock Face

   This tender item applies to those excavations that are part of the final roadway, whether highway, side road, entrance, detour, etc.

206-2.1.3 Other Excavation Tender Items
Rock excavation for the following is not carried out under the item "Rock Excavation (Grading)", but under separate tender items and governing Ontario Provincial Standard Specifications:

- Culverts
- Sewers, Manholes, Catchbasins, Ditch Inlets
- Subdrains
- Structures

These items are detailed elsewhere in this Chapter.

206-2.1.4 Specifications

Details of the work of "Rock Excavation (Grading)" and "Rock Face" are contained in OPSS 206.

206-2.1.5 Special Provisions

The designer should investigate to determine whether any Standard Special Provisions are required to be included in the contract.

206-2.1.6 Standard Drawings

To establish physical limits upon which to base quantities, the designer must be familiar with the Ontario Provincial Standard Drawings Manual - 200 series.

206-2.2 COMPUTATION

These are Plan Quantity Payment items.

In computing rock quantities - cut and fill - the designer will subtotal the figures every 350 m along the highway; also on service roads, sideroads, detours, ramps and entrances where the length justifies such a breakdown. Each subtotal will constitute a single-line entry on the "Quantities - Grading" sheet.

Where stage construction is proposed, quantities must be considered on a stage basis, as material excavated in one stage may not be available for fill purposes in a different stage.

Rock Face quantities are computed for each rock face, left and right sides separately, and listed on the "Quantities -Grading" sheet or Quantities Miscellaneous sheet.
At sideroads and entrances the rock face will follow the flare to the end of the individual rock face.

206-2.2.1 Source of Information

A. Design Criteria

This document contains the approved parameters governing the alignment and cross section of the main roadway in a project.

B. Survey Information

Field notes are produced by survey crews, and provide details of existing surface features on the main roadway, sideroads and entrances, as well as data for the new horizontal and vertical alignments.

Cross sections are recorded by survey crews using rod and level, for plotting either manually or by machine. Surveys and Plans Office also provide cross sections obtained by means of aerial photography.

Designers should take the surveys information into consideration to establish the best possible rock line. The final interpretation should be reviewed with the Regional Geotechnical Section

C. Soils Profile

The Soils Profile shows the existing groundline, rockline, proposed vertical alignment and existing drainage data. Also shown are the relevant soils data and grading and granular base recommendations specified by the Regional Geotechnical Section.

D. Reports

A number of reports contain data required by the designer to establish cross sections upon which cut and fill quantities will be based. These reports are:

- Geotechnical Report
- Preliminary Design Report
- Environmental Assessment Report

E. Field Review

206-2.2.2 Components of Rock Excavation (Grading)

A. Rock Cut for Roadways, Interchanges, Detours,
Sideroads and Entrances

Rock cut is material classified as rock as per OPSS 206, and which is excavated from rockline down to the top of shatter (i.e. bottom of granular sub-base), as outlined in the theoretical section applicable to a particular project. The volume of rock cut is estimated using the end area method, with the appropriate areas determined geometrically, measured by planimeter or electronically computed.

Quantities are computed separately for roadways, interchanges, detours, etc., and subtotalled at intervals of 350 m.

The designer should investigate cut sections that may require widening beyond the limits set in the standards in order to maintain traffic during stage construction. Where widening is necessary it should be considered as a detour and the appropriate quantities should be included in the tender.

Excavated rock is a fully usable material for embankment construction and backfilling, and the total volume computed is considered available for use.

When rock blasting adjacent to existing paved surfaces which are not being removed or resurfaced then, an appropriate hot mix surface course quantity must be computed as detailed in chapter B 313-1.1.10 of this Manual.

B. Shatter

In a rock cut section, to ensure a stable sub-base and provide drainage, the top 0.3 m of rock subgrade is shattered, since continual pounding from traffic and the eroding forces of storm runoff would shift the granular materials, causing pavement failure. To prevent such damage the top 0.3 m of rock grade is "shattered" and the resultant rock fragments left in place to provide a rock "matting" which would hold any granular materials placed.

Shatter is not required in a shale subgrade.

It may be necessary to shatter deeper than 0.3 m in order to facilitate drainage of the granular base, as shown in Figure B206-2-1. Where this is the case, the total depth of shatter must be shown on the drawings.

All shatter shown on the drawings, regardless of depth, is computed at full volume.

Shatter quantities are subtotalled at the same breakdown intervals as those for rock cut quantities.

C. Frost Treatment
Frost heaving of the roadbed may result from water trapped in hollows formed between knobs of rock at shallow depths. Treatment to provide drainage may include rock shatter below subgrade, as shown in Figure B206-2-2.

D. Rock Excavation for Intake/Offtake Ditching and Water Course Correction

(1) Intake/Offtake Ditching

Ditching in rock, other than side ditches in cut sections, usually means intake/offtake ditching at culvert locations. Interceptor/catch ditches are not required on rock surfaces, except if they are a continuation of other ditches.

Figure B206-2-3 illustrates the cross section of a typical ditch in rock.

The quantity of ditching is calculated from cross sections using depths from a set ditch profile. The material obtained from rock ditching usually is available for embankment construction.

Areas of Rock Face are not computed for ditching.

Shatter is not required for Rock ditching.

(2) Watercourse Correction

Watercourse correction is defined as an alteration to a natural watercourse, excluding the lengths of any culverts and culvert aprons. Excavation within the limits of a culvert (and its aprons) is considered part of the work of other tender items and is paid for accordingly.

The excavated rock material resulting from watercourse correction although generally accepted as available for fill, is rarely used to fill in the old watercourse; it is more commonly used for embankment construction.

Areas of Rock Face are not computed for watercourse correction.

E. Boulders

The Regional Geotechnical Section, on the basis of field investigations, may include in their report findings an evaluation of boulders (those measuring 1.0 m$^3$ or larger) existing in some cuts. Because of the difficulty in determining their volume, the Regional Geotechnical section may recommend a percentage factor be used for calculation purposes.

After computing the volume of excavation based on an earth cut section, the following procedure should be implemented;
<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of Earth Cut Section</td>
<td>10 000 m³</td>
</tr>
<tr>
<td>Less: Volume of Boulders (10%, or as recommended by Regional Geotechnical Section)</td>
<td>1 000 m³</td>
</tr>
<tr>
<td>Earth Cut Quantity</td>
<td>9 000 m³</td>
</tr>
</tbody>
</table>
DETAIL ESTIMATING ROCK EXCAVATION (GRADING)

206-2.2.3  Rock Face

Fig.B206-2-1

Fig.B206-2-2

Fig.B206-2-3
Working from cross sections, the designer will compute the surface area, in square metres, of the rock faces in each rock cut section. The vertical limits of the rock face are top of rock (rockline) to bottom of ditch.

The rock face item does not apply to slopes in shale.

206-2.2.4 Utilization and Disposal of Materials

Ontario Provincial Standard Specifications state that all rock excavated from roadway cuts, including expanded shatter, shall be placed in roadway embankments. All rock excavated from other sites such as drains, ditches and channels shall, if required and feasible, also be placed in roadway embankments. An attempt should be made to accommodate a maximum of excavated rock in embankments. Only after all possibilities of utilization within the contract limits are extracted should excess materials be designated for disposal outside the R.O.W.

Computed quantities need to be adjusted to compensate for expansion due to voids when using broken rock material in roadway embankments or as backfill, and the designer should refer to Appendix "A" to this Chapter for the applicable volume adjustment factor.

(a) Embankment Construction (Rock Fill)

Rock fill is material available from cuts, shatter, ditching and watercourse corrections in rock, and includes boulders, all of which is placed in the embankment to the cross section of the applicable rock fill standard. Rock material may be placed in sections of earth fill, swamp backfill or any other area recommended by the Regional Geotechnical Section, however, it is designated, calculated and detailed as "Rock Fill".

(1) Combination Fills (Rock and Earth)

Embankments may consist of both earth and rock materials in varying proportions. When earth is the predominant grading material the earth fill section standard is applied even though the project contains some rock excavation. The method of calculation is as follows:

| Volume of Fill (based on Earth Fill Section) | 10 000 m³ |
| Less: Available Rock Fill (includes expansion factor) | 2 000 m³ |
| Earth Fill Volume | 8 000 m³ |
| Earth Fill Required (assuming a 15% volume adjustment factor) | 9 200 m³ |
When rock is the predominant grading material the rock fill section standard is applied even though the project contains some earth excavation. The method of calculation is as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of Fill (based on Rock Fill Section)</td>
<td>10 000</td>
</tr>
<tr>
<td>Less: Available Rock Fill (includes expansion factor)</td>
<td>9 000</td>
</tr>
<tr>
<td>Earth Fill Volume</td>
<td>1 000</td>
</tr>
<tr>
<td>Earth Fill Required (assuming a 15% volume adjustment factor)</td>
<td>1 150</td>
</tr>
</tbody>
</table>

In these examples, note that in each case the total quantity of available rock material (major or minor) is utilized before computing earth fill requirements.

(2) Rock Fill (Boulders)

In earth embankments where boulders from adjacent cuts are used for fill, quantities are adjusted as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of Fill</td>
<td>12 000</td>
</tr>
<tr>
<td>Less: Rock Fill (Boulders)*</td>
<td>1 000</td>
</tr>
<tr>
<td>Earth Fill Volume</td>
<td>11 000</td>
</tr>
<tr>
<td>Earth Fill Required (assuming a 15% volume adjustment factor)</td>
<td>12 650</td>
</tr>
</tbody>
</table>

*The rock expansion factor is not applied to boulders placed in earth fills.

Boulders, cobbles, and fragments of rock and reclaimed materials should not be disposed of in areas where pile driving for future structures is envisaged. Boulders, etc. can result in piles being "hung up" within this material and not reaching the designed tip elevations. Contract documents should demarcate areas where this option is prohibited i.e. those areas where structures are planned in the future.

(b) Swamp Backfill (Rock)

Rock may be used as backfill to swamp excavation.

(c) Frost Heave Backfill

Roadbeds excavated for frost heave treatment will be backfilled with granular material in accordance with Ontario Provincial Standard Drawings, as set out in Section B314 of this Chapter.

(d) Structure Backfill (Rock)
Concrete structures may be backfilled with rock. In certain circumstances, when granular material is not readily available or in order to reduce high granular costs, rock available for fill may be used as backfill material. Before opting for rock backfill, a cost comparison must be completed to determine the selection of the more economical alternative.

When rock is used as structure backfill, a standard Special Provision must be included stating the gradation of the backfill material, together with Standard Drawings. A separate tender item is not required.

(e) Drainage Gap in Rock Fills

When surplus or unsuitable material is designated for flattening rock fills, gaps in the flattening material must be provided at the low point for cross drainage and at other strategic locations according to OPSD.

Neglect to provide drainage gaps may result in embankment failure due to hydrostatic pressure or frost action.

The location of the drainage gaps should be indicated on the contract drawings by station and standard number.

206-2.2.5 Methods of Calculation

The basic unit of measurement for "Rock Excavation (Grading)" is the cubic metre, and for "Rock Face" the square metre.

A. Manual Computation

(1) Cross Sections

Except for certain volume adjustment factors and the completion of forms, as mentioned in this Section, the methods of calculation for rock quantities are similar to those for earth excavation.

(2) Forms

Following the measurement of end areas, they are then listed on Form PH-D-420 - "Earth and Rock Quantities," and the computation of volumes for each type of work - rock cut, shatter, ditching, etc., is detailed separately in individual columns.

(3) Mass Haul Diagram

Mass haul diagrams are to be prepared for all major grading projects, as discussed in Section B206-1 of this Chapter, and to which the designer should refer.
B. Electronic Computation

Electronic computation of grading quantities has largely replaced manual methods. The designer should refer to Section B206-1 of this Chapter for a list of manuals covering the use of computer programmes.

206-2.3 DOCUMENTATION

Documentation procedures (detailed on drawings, quantity sheets and tender forms) for "Rock Excavation (Grading)" follow the principles of those for "Earth Excavation (Grading)" - Section B206-1 of this Chapter.

A. Contract Drawings

Care must be exercised in the precise interpretation of soils information and boring. The elevations of solid rock formations must be plotted on cross sections and contract profiles.

When extensive side cut occurs throughout a project, a typical section should be shown on the drawings, as this condition can greatly affect the bid price for rock, and bidders should be effectively informed.

B. Contract Documents

Rock excavation volumes, and shatter volumes, shown on the "Quantities Grading" sheet, are extended to the "Rock Material Available" column following incorporation of a suitable volume adjustment (expansion) factor, as set out in Appendix 'A' to this Chapter.

The total computed volume of large surface boulders (Rock) must be shown as a separate entry on the "Quantities - Grading" sheet.

Rock required for structure backfill shall be identified on the "Quantities - Grading" sheet as "Rock Backfill to Structure," with a separate entry for each structure under the column heading "Fill Required - Rock".

When stage construction occurs, quantities must be documented for each separate stage.

Material that is to be incorporated inside the right-of-way must have its location shown on the plans and the quantity shown on the "Quantities - Grading" sheet. When it is necessary to dispose of excess material outside the right-of-way, the location of disposal sites is the responsibility of the contractor.

When there are only a few entries, Rock Face is shown on the "Quantities - Grading" sheet, within each 350 m breakdown. More numerous entries are shown on the "Quantities - Miscellaneous" sheet, with each rock face shown fully per entry, and not subject to the 350 m breakdown.