

B314 - UNTREATED SUBBASE, BASE, SURFACE, SHOULDER, SELECTED SUBGRADE, AND STOCKPILING (OPSS 314) *DRAFT*

314.1 GENERAL

Granular materials meeting the requirements of OPSS 1010 are obtained from pits and quarries, and recycled materials.

Granular A and Granular B, Type I are the materials commonly used for base and subbase, respectively.

Granular O and Granular M are two alternatives for Granular A. Granular O has increased permeability and is specified where improved pavement base drainage is required. Granular M has a finer gradation and is typically used for gravel road and shoulder maintenance, and the base layer for gravel roads.

Granular B, Type II and Granular B, Type III are two alternatives for Granular B, Type I. Granular B, Type II is a 100% crushed high stability material that is primarily specified for use in conjunction with rock grading. Granular B, Type III is specified where it is cost effective to avoid the use of problematic local uniformly-graded fine sands.

Reclaimed asphalt pavement (RAP) is the processed hot mix asphalt material that is recovered by partial or full depth removal. It may be specified for use in the shoulder rounding areas of paved shoulder locations.

314.2 REFERENCES

OPSS 1010, Aggregates - Base, Subbase, Select Subgrade, and Backfill Material
 OPSS 405, Pipe Subdrains
 Geometric Design Standards for Ontario Highways
 CDED B206-1, Earth Grading
 CDED B206-2, Rock Grading

314.3 TENDER ITEMS

Unit of Measure (t)

Granular A	by t, Variation
Granular B, Type I	by t, Variation
Granular B, Type II	by t, Variation
Granular B, Type III	by t, Variation
Granular M	by t, Normal
Granular O	by t, Normal
Select Subgrade Material, Compacted	by t, Normal
RAP Shouldering	by t, Normal

Unit of Measure (m²)

RAP Shouldering	by m ² , Normal
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Unit of Measure (m³) - (End Area Method)

Granular A (End Area Method)	by m ³ , Normal
Granular B, Type I (End Area Method)	by m ³ , Normal
Granular B, Type II (End Area Method)	by m ³ , Normal
Granular B, Type III (End Area Method)	by m ³ , Normal
Granular M (End Area Method)	by m ³ , Normal
Granular O (End Area Method)	by m ³ , Normal
Select Subgrade Material, Compacted (End Area Method)	by m ³ , Normal

Unit of Measure (m³) - (Truck Box Method)

Granular A (Truck Box Method)	by m ³ , Normal
Granular B, Type I (Truck Box Method)	by m ³ , Normal
Granular B, Type II (Truck Box Method)	by m ³ , Normal
Granular B, Type III (Truck Box Method)	by m ³ , Normal
Granular M (Truck Box Method)	by m ³ , Normal
Granular O (Truck Box Method)	by m ³ , Normal
Select Subgrade Material, Compacted (Truck Box Method)	by m ³ , Normal

Unit of Measure (t) - Stockpiled

Granular A, Stockpiled	by t, Normal
Granular B, Type I, Stockpiled	by t, Normal
Granular B, Type II, Stockpiled	by t, Normal
Granular B, Type III, Stockpiled	by t, Normal
Granular M, Stockpiled	by t, Normal
Granular O, Stockpiled	by t, Normal

Unit of Measure (m³) - Stockpiled (End Area Method)

Granular A, Stockpiled (End Area Method)	by m ³ , Normal
Granular B, Type I, Stockpiled (End Area Method)	by m ³ , Normal
Granular B, Type II, Stockpiled (End Area Method)	by m ³ , Normal
Granular B, Type III, Stockpiled (End Area Method)	by m ³ , Normal
Granular M, Stockpiled (End Area Method)	by m ³ , Normal
Granular O, Stockpiled (End Area Method)	by m ³ , Normal

Unit of Measure (m³) - Stockpiled (Truck Box Method)

Granular A, Stockpiled (Truck Box Method)	by m ³ , Normal
Granular B, Type I, Stockpiled (Truck Box Method)	by m ³ , Normal
Granular B, Type II, Stockpiled (Truck Box Method)	by m ³ , Normal
Granular B, Type III, Stockpiled (Truck Box Method)	by m ³ , Normal
Granular M, Stockpiled (Truck Box Method)	by m ³ , Normal
Granular O, Stockpiled (Truck Box Method)	by m ³ , Normal

Unit of Measure (t) - from Stockpile

Granular A, from Stockpile	by t, Normal
Granular B, Type I, from Stockpile	by t, Normal
Granular B, Type II, from Stockpile	by t, Normal
Granular B, Type III, from Stockpile	by t, Normal
Granular M, from Stockpile	by t, Normal

Granular O, from Stockpile

by t, Normal

Unit of Measure (m³) - from Stockpile (End Area Method)

Granular A, from Stockpile (End Area Method)

by m³, Normal

Granular B, Type I, from Stockpile (End Area Method)

by m³, Normal

Granular B, Type II, from Stockpile (End Area Method)

by m³, Normal

Granular B, Type III, from Stockpile (End Area Method)

by m³, Normal

Granular M, from Stockpile (End Area Method)

by m³, Normal

Granular O, from Stockpile (End Area Method)

by m³, NormalUnit of Measure (m³) - from Stockpile (Truck Box Method)

Granular A, from Stockpile (Truck Box Method)

by m³, Normal

Granular B, Type I, from Stockpile (Truck Box Method)

by m³, Normal

Granular B, Type II, from Stockpile (Truck Box Method)

by m³, Normal

Granular B, Type III, from Stockpile (Truck Box Method)

by m³, Normal

Granular M, from Stockpile (Truck Box Method)

by m³, Normal

Granular O, from Stockpile (Truck Box Method)

by m³, Normal

Select Subgrade Material used to backfill swamp excavations is a different tender item. Refer to Section B209 for details.

314.4 SPECIFICATIONS

The requirements for untreated subbase, base, surface, shoulder, RAP Shouldering, selected subgrade, and stockpiling are contained in OPSS 314.

314.5 SPECIAL PROVISIONS

Refer to Chapter 'E' of this manual to review the applicable standard special provisions.

314.6 STANDARD DRAWINGS

Applicable standard drawings are contained in the OPSD 200 series.

314.7 DESIGN

Typical applications for the materials are indicated in the table below.

Material	Typical Applications
Granular A	- Granular base for pavement structure - Shouldering - Bedding for sidewalk, curb and gutter, culvert, sewer, gabion - Frost heave treatment
Granular B, Type I Granular B, Type II Granular B, Type III	- Granular sub-base for pavement structure - Culvert and sewer embedment / cover - Structure approach treatment backfill - Frost heave treatment - Subdrains - Drainage layer
Granular M	- Shoulder maintenance - Gravel road maintenance - Surface course (gravel roads) - Restoring unpaved roadway surfaces
Granular O	- Granular base for pavement structure - Drainage layer
Select Subgrade Material, Compacted	- Backfill to excavations below subgrade for frost mitigation - Embankment fill where local earth materials unsuitable
RAP	- Granular Shoulder

The required thickness of roadbed granular is determined using current Ontario pavement design practices and regional experience.

Where pavement binder courses are placed, RAP shouldering shall have a compacted thickness matching the thickness of the adjacent binder courses and shall extend to the shoulder rounding, unless otherwise recommended by the Regional Geotechnical Section.

Where pavement surface course is placed, RAP shoulder shall have a compacted thickness matching the adjacent new paved shoulder and shall extend from the new paved shoulder to the shoulder rounding.

The type of roadbed granular is project and location specific. In some areas of the province, certain types of granular materials are used in order to avoid problem materials or to conserve materials that are in short supply for local development.

In Ontario's wet-freeze-thaw climate, pavement design for frost action is critical. Refer to Section B206-1 for typical grading practices used to mitigate frost action risk. An increase in roadbed granular depth, beyond the depth required for strength, may be necessary for some projects/locations to further mitigate frost action.

Refer to the other sections of this Chapter for information on the use of granular for other applications.

314.8 COMPUTATION**314.8.1 General**

These items are measured items.

On most projects, the unit of measurement for all granulars is the tonne. However, for the RAP Shouldering item, the unit of measurement is by m².

On projects where the total quantity of granular materials is less than 5,000 tonnes, weigh scales may not be practical, and the unit of measurement is the cubic metre.

When computing quantities of granular subbase, base, RAP Shouldering, surface, shoulder, selected subgrade, subtotal the quantities every 350 m along the highway, service roads, sideroads, detours, ramps and entrances.

For divided highways, quantities are calculated separately for each direction of travel.

For projects with stage construction, granular quantities are to be determined separately for each stage of the work.

Separation of quantities may also be required for left and right sides where it will clarify the quantity information. This could apply to widening projects, reconstruction projects and other work as appropriate.

Drawings and cross-sections are used to establish the physical limits on which to base quantities.

314.8.2 Components of Granular Items**A. Roadbed**

The four components of roadbed granular to be computed are:

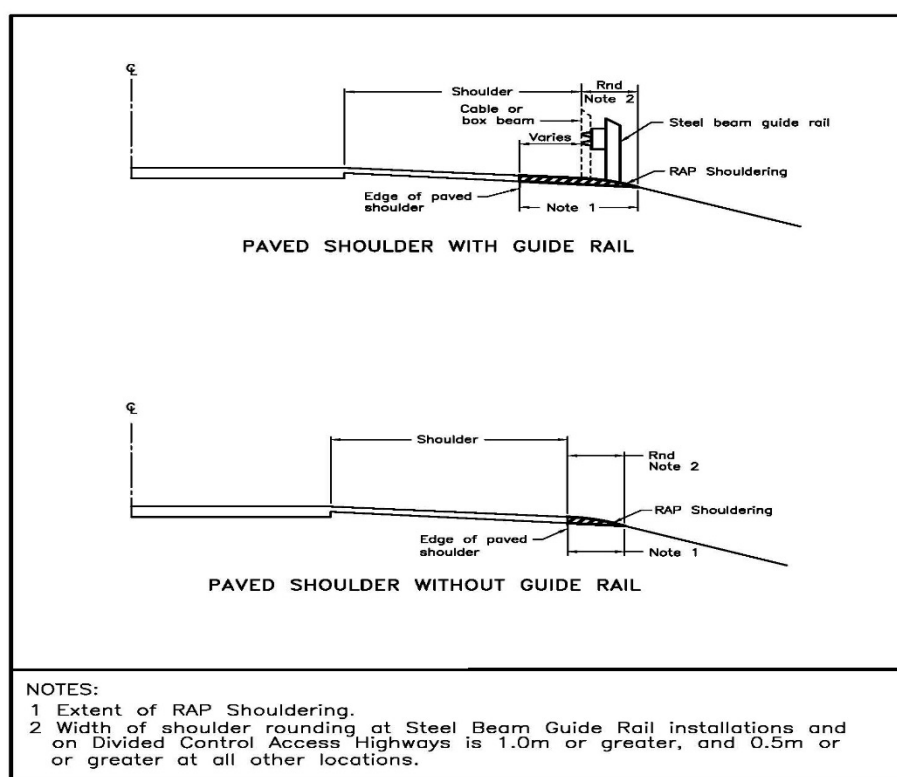
- 1) Granular Base which is a layer of granular material generally composed of high stability graded crushed gravel or stone. It is a load bearing layer, provides drainage, a smooth riding surface for paving, and reduces frost action.
- 2) Granular Subbase which is normally a non-processed material obtained from local gravel or sand pits and is placed on the subgrade. It performs the same function as a granular base except that it can be of lower quality. In some cases, it is processed from quarries.
- 3) Shouldering which is the layer of granular material placed on top of the granular base material and adjacent to the pavement, including the Rounding.
- 4) Rounding which is the area of the shoulder at the point of intersection of the shoulder slope and the embankment or ditch slope.

The width of rounding is usually 1.0 m or greater at steel beam guide rail installations and on divided controlled access highways, and 0.5 m or greater at all other locations.

Where milling of asphalt is included in the contract and is available to the contractor, the use of reclaimed asphalt pavement (RAP) should be considered to replace a portion of the volume of granular material for shoulder rounding, adjacent to paved shoulders.

When RAP Shouldering is specified, it replaces a portion the material in the Granular shoulder from the edge of the paved shoulder outwards to the outside edge of the rounding, as shown in the drawings below.

Examples:



B. Backfill

Refer to the respective sections of this Chapter for the computation requirements for granular backfill to structure excavations, frost heave treatments, and other applications.

C. Stockpiles

Granular materials may be stockpiled for future use or may be available for use on the project. The amount of granular material to be stockpiled, or available for use, is based on information from the regional maintenance and geotechnical staff.

314.8.3 Methods of Calculation

To compute quantities, the first step is to compute the volume of compacted material required. Granular quantities are usually determined with electronic computation. However, in instances of small minor areas, it may be efficient and appropriate to use manual methods. The use of manual calculations to determine quantities is to be approved by Ministry management staff in the Planning and Design Section.

Quantities are to be determined using the average end area method, except for intersections, roundabouts, parking lots, and other similar locations where other methods achieve better quantity estimates.

Computer applications have many methods of calculating volumes and therefore it is important to ensure that the desired method is selected. The current version of the computer application in use with the Ministry for highway design is to be used for the design and determining granular quantities, when electronic computation is to be completed.

314.8.3.1 Tonne

If the unit of measurement is the tonne, the volume of compacted material is multiplied by the appropriate conversion factor to obtain tonnes. The geotechnical staff on the project should always be requested to confirm the conversion factors for each contract. However, default conversion factors are:

Granular A ¹ Granular M ¹ Granular O ¹	2.2 t/m ³	Multiply volume (m ³) of compacted granular by 2.2 to obtain tonnes(t)
Granular B, Type I Granular B, Type II Granular B, Type III	2.0 t/m ³	Multiply volume (m ³) of compacted granular by 2.0 to obtain tonnes(t)
Select Subgrade Material, Compacted	1.8 t/m ³	Multiply volume (m ³) of compacted SSM, compacted by 1.8 to obtain tonnes(t)
RAP shouldering	2.4 t/m ³	Multiply volume (m ³) of compacted RAP shouldering by 2.4 to obtain tonnes(t)

314.8.3.2 Cubic Metre

If the unit of measurement is the cubic metre, the volume of material is measured in the field by either the End Area Method (i.e. volume of material in the original position in the pit or by the Truck Box Method, as outlined in OPSS 314. These methods measure the volume of uncompacted material. To establish the volume of uncompacted material required, the designer increases the volume of the compacted material by the amounts shown below, unless otherwise specified by the Regional Geotechnical Section.

Measurement Method	Material	Increase for Uncompacted Volume
End Area	Granular	15%
	Selected Subgrade	10%
Truck Box	Granular	20%
	Selected Subgrade	15%

Granular for shoulders for resurfacing contracts are commonly overrun. A careful assessment shall be made of existing shoulder width, cross-fall, and edge of pavement drop off to obtain an accurate estimate. When the design precedes the construction by a considerable length of time, the shoulder conditions should be reviewed again just prior to award of the contract and the estimated quantities adjusted as required.

314.8.3.3 Square Metre

When the unit of measurement for the RAP Shouldering is m², the computed area is the product of the lengths and widths of the shoulder rounding detailed in the contract drawings.

314.8.4 Contingencies and Allowances

Refer to B999-A - APPENDIX "A" in this Chapter for information on the "Contingencies and Allowances" to be applied to computed quantities.

314.8.5 Source of Information

The recommended depth and selection of type of granular materials to be used is the responsibility of the geotechnical staff on the project and may be found in the Pavement Design Report, Geotechnical Report and/or Soils Profile.

The crossfall of granular courses and shouldering is governed by the Geometric Design Standards for Ontario Highways.

The roadway configuration is governed by the Design Criteria.

314.9 DOCUMENTATION

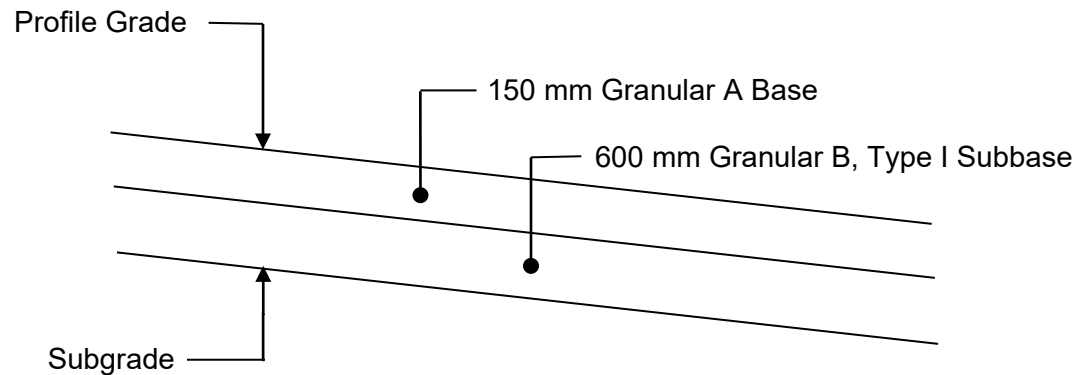
314.9.1 Contract Drawings

Profiles

Profile grade is preferred for identifying grade control. The types and depths of granular are shown (see below).

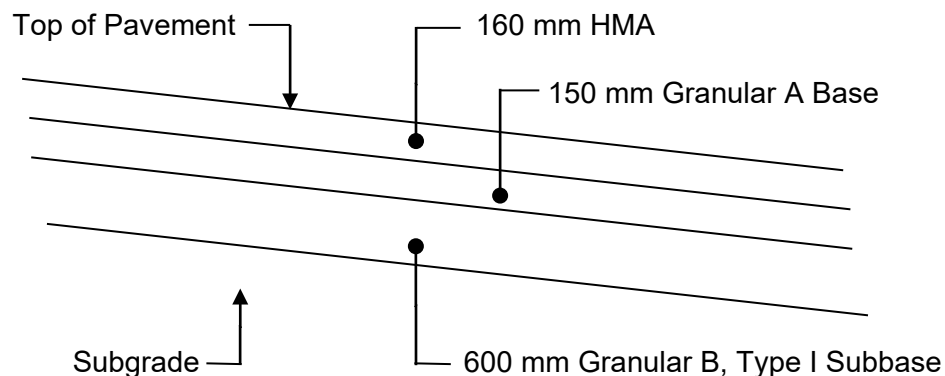
The depths should appear at least once on each profile sheet, and at every location where there is a change in thickness.

When there is a change in design granular depth due to subgrade condition, traffic loading, interchange/intersection, or other reason, the transition rate between the change in depth is to be shown. The transition rate is typically 10H:1V or as recommended by the geotechnical staff on the project.



Refer to Section B206-1 and B206-2 for documentation requirements for transition treatments due to change in subgrade (e.g. earth fill to rock fill transition).

When it is necessary to show “top of pavement” for grade control, the types and depths of granular are shown along with the total depth of pavement, e.g.



Other methods of showing granular requirements on profile sheets are permitted, with MTO project manager approval.

The types and depths of granular base, subbase, shoulder and RAP Shouldering are to be shown on typical sections. When standard drawings are used to indicate granular base requirements, then the types and depths are to be shown in a tabular format in the contract drawings.

References to granular material on contract drawings should, where applicable, include the term ‘base’, ‘subbase’, ‘surface’, ‘shoulder’, ‘RAP Shouldering’, ‘selected subgrade’, and ‘stockpiling’, consistent with the specification terminology.

314.9.2 Quantity Sheets – Roadbed Quantities

Roadbed granular quantities are broken down into the following components:

Main Highway	
Service Roads	Side Roads
Ramps	Detours
Commercial Entrances	Private Entrances

These quantities are included as separate entries on the Quantities - Hot Mix and Granular sheet. The quantities are to include backfill quantities to transition treatments.

The quantity interval is work type specific and is to be established by the MTO project manager, based on the following:

- a) New Construction / Pavement Reconstruction - quantities are entered every 350 m (or less, where applicable) road length, by station limits, matching the interval used on Grading Q-sheets.
- b) Pavement Rehabilitation - quantities are entered every 700 m (or less, where applicable) road length, by station limits.
- c) Pavement Resurfacing - granular is typically required for shouldering only. At least one shouldering granular quantity is entered for each direction of travel.

Where the project has multiple work types, the interval may vary for different areas of the project depending on the work type.

Quantity separation may be required for left and right sides to clarify the quantity information. This could apply to widening projects and other work as appropriate.

Granular A and Granular B, Type I, Type II, and Type III, when paid by the tonne, are variation items. The variation is the type of application. The variations and the application description are selected by the designer. Typical application descriptions include Base, Subbase, Surface, Shoulder, Backfill, Bedding. The quantities for each variation are entered on separate Q-sheet columns.

If the unit of measurement is in cubic metres, then the item containing "(End Area Method)" or "(Truck Box Method)" as appropriate is selected. See CPS item master file for exact item description.

If a portion of the granular material will be supplied by the Ministry from an existing stockpile(s), the quantity is included in the Schedule of Materials to be Supplied by the Ministry, and the designer will choose a general granular item description (e.g: Granular B, Type II).

"Granular..., Stockpiled" items require a separate entry per stockpile location.

Select Subgrade Material, Compacted is entered on the Quantities - Hot Mix and Granular sheet in its own column(s) separate from the others.

The RAP Shouldering item quantities are entered on the Quantities – Hot Mix and Granular sheet showing station to station and location (left or right of centreline).

Where the existing driving lanes are to be excavated for the installation of pipes etc., the roadbed must be reinstated with appropriate granular subbase and base depths and types as recommended by the geotechnical staff on the project. The work is further detailed in the applicable sections of this chapter. The granular quantities, above subgrade only, required for the roadbed reinstatement are included with the roadbed quantities.

The tender totals for each of the granular items listed in this section are transferred to the tender documentation.

314.9.3 Quantity Sheets – Other Granular

When granular quantities for other components of the work are to be included, the quantity is first entered in a granular quantity column on the quantity sheet for the work component, and the total transferred to the Quantities - Hot Mix and Granular sheet. Refer to the CDED sections listed for further information.

Other granular quantities are to be entered on the Quantities - Hot Mix and Granular sheet as follows:

Work Component / Item	Ref	Q-Sheet Description Column	Note
Drainage Gaps	B206-1	Drainage Gaps Backfill	One line entry / contract
Frost Heave Treatment	B206-1	Frost Heave Treatment Backfill, Sta. to Sta.	One line entry / treatment
Swamp Backfill	B209	Backfill to Swamp, Sta. to Sta.	One line entry / swamp
Wick Drains	B209	Wick Drains Granular Blanket, Sta. to Sta.	One line entry / wick drains area
Extruded Expanded Polystyrene Treatment	B316	Expanded Polystyrene Treatment Backfill, Sta. to Sta.	One line entry / treatment
Asphalt Sidewalk	B311	Asphalt Sidewalk Base	One line entry / contract
Concrete Sidewalk	B351	Concrete Sidewalk Base	One line entry / contract
Subdrains (Note 1)	B405	Subdrain Bedding, Embedment, and Backfill	One line entry / contract
Precast Box Culvert	B422	Precast Box Culvert Bedding and Backfill, Sta. to Sta.	One line entry / culvert
Precast Box Sewer	B422	Precast Box Sewer Bedding and Backfill, Sta. to Sta.	One line entry / sewer
Removals	B510	Removals Backfill	One line entry / contract
Gabion Structures	B512	Gabion Structure Bedding, Sta. to Sta.	One line entry / structure

Work Component / Item	Ref	Q-Sheet Description Column	Note
Concrete Barrier	B740	Separated Concrete Barrier, Granular Fill	One line entry / contract
Earth Excavation for Structure	B902	"Structure Name", Bedding and Backfill	One line entry / structure
Rock Excavation for Structure	B902	"Structure Name", Bedding and Backfill	One line entry / structure
Note: 1. When the specified granular embedment and backfill material for the subdrain is different from the granular items in the contract, the granular embedment and backfill material is included with the subdrain item. Refer to OPSS 405.			

314.9.4 Documentation Accuracy

All quantities are rounded to whole numbers.

314.9.5 Non-Standard Special Provisions

Write project and item specific requirements in a NSSP using the standard format described in this manual.

Topics that may require a NSSP include:

- Details on locations for granular to be stockpiled or to be taken from stockpiles, including contact names, advance notification, etc.
- Granular surcharge placement and compaction, timing, and removal requirements
- Changes to compaction requirements e.g., over soft ground
- Where alternative materials are required or allowed (e.g. lightweight granular blast furnace slag)
- Re-use of existing granular that is to be excavated
- Staged construction and traffic management using granular materials
- Gradation changes required for specific applications