Worked Examples – Non-metallic minerals

Version – 27th June 2022

For the following, use any or all the data provided in each exercise to produce the required estimates

A.3.8 Sand, gravel, crushed rock ("Sand and gravel")

1. *A.3.8 Concrete component exercise.*

Example

Construct an estimate of the Sand and gravel required to make concrete in xx for the years 2019 and 2020 using the appropriate tool on the Questionnaire and the sources of data provided and/or linked below:

USGS Mineral Commodities summary 2020 at
https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-cement.pdf

Year	Trade Flow	Reporter	Partner	HS Code	Commodity	Netweight (kg)	Trade Value (US$)
2019	Export	Brazil	World	2523	Portland cement, aluminous cement (ciment fondu), slag cement, supersulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinkers		11,361,979
2019	Export	Brazil	World	252310	Cement clinkers (whether or not coloured)	15	26
2019	Export	Brazil	World	252321	Cement; portland, white, whether or not artificially coloured	250	1,770
2019	Export	Brazil	World	252329	Cement; portland, other than white, whether or not artificially coloured	174,766,091	11,044,681
2019	Export	Brazil	World	252330	Cement; aluminous (ciment fondu), whether or not coloured or in the form of clinkers		305,926
2019	Export	Brazil	World	252390	Cement; hydraulic kinds n.e.c. in heading no. 2523	10,524	9,576
2019	Import	Brazil	World	2523	Portland cement, aluminous cement (ciment fondu), slag cement, supersulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinkers	629,103,556	56,475,781
2019	Import	Brazil	World	252310	Cement clinkers (whether or not coloured)	455,863,812	27,169,352
2019	Import	Brazil	World	252321	Cement; portland, white, whether or not artificially coloured	131,121,499	15,232,959
2019	Import	Brazil	World	252329	Cement; portland, other than white, whether or not artificially coloured	23,871,079	1,907,669
2019	Import	Brazil	World	252330	Cement; aluminous (ciment fondu), whether or not coloured or in the form of clinkers	12,917,137	8,971,183
2019	Import	Brazil	World	252390	Cement; hydraulic kinds n.e.c. in heading no. 2523	5,330,029	3,194,618
2020	Export	Brazil	World	2523	Portland cement, aluminous cement (ciment fondu), slag cement, supersulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinkers		23,382,456
2020	Export	Brazil	World	252310	Cement clinkers (whether or not coloured)		96
2020	Export	Brazil	World	252321	Cement; portland, white, whether or not artificially coloured	379,304	58,415
2020	Export	Brazil	World	252329	Cement; portland, other than white, whether or not artificially coloured	378,290,682	23,123,444
2020	Export	Brazil	World	252330	Cement; aluminous (ciment fondu), whether or not coloured or in the form of clinkers	292,712	200,452
2020	Export	Brazil	World	252390	Cement; hydraulic kinds n.e.c. in heading no. 2523	11	49
2020	Import	Brazil	World	2523	Portland cement, aluminous cement (ciment fondu), slag cement, supersulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinkers	598,155,672	50,259,614
2020	Import	Brazil	World	252310	Cement clinkers (whether or not coloured)	442,036,200	22,389,560
2020	Import	Brazil	World	252321	Cement; portland, white, whether or not artificially coloured	136,906,238	15,960,784
2020	Import	Brazil	World	252329	Cement; portland, other than white, whether or not artificially coloured		226,514
2020	Import	Brazil	World	252330	Cement; aluminous (ciment fondu), whether or not coloured or in the form of clinkers	12,481,437	7,867,260
2020	Import	Brazil	World	252390	Cement; hydraulic kinds n.e.c. in heading no. 2523	5,857,069	3,815,496

1) Trade data downloaded from https://comtrade.un.org/data/ (many columns removed here for readability)

Cement Sales 2020-2021

Month	2020	2021
January	4,437,000	5,084,000
February	4,237,000	4,705,000
March	4,179,000	5,437,000
April	4,100,000	5,291,000
May	4,824,000	5,501,000
June	5,382,000	5,438,000
July	5,929,000	5,942,000
August	5,829,000	5,896,000
September	5,839,000	5,698,000
October	5,944,000	5,339,000
November	5,288,000	5,384,000
December	4,683,000	4,757,000
Total	60,210,000	64,472,000

Source: SNIC

Cement sales for Brazil, tonnes. Sourced from https://cementproducts.com/2022/04/11/report-from-brazil/, accessed 25 May 2022 (from search using *cement imports Brazil tonnes*)

Solution

The table in 3) above provides us with a number that could serve more-or-less directly as a reasonable estimate for cement consumption for 2020 (60,210,000 tonnes).

However, as the tool works by calculating consumption from production + imports – exports, and we also want a cement production figure to for calculation of A.3.2 Carbonate minerals important in cement, we should use it to derive a production figure instead. We can do this if we have trade data as well.

For the trade data, we have downloaded data from the Comtrade database in the table shown in 2) above.

In the simplest case, if we would use the tonnages given for both exports and imports under the 2523 HS Code, which aggregates all cement types for us. In this case, however, are only tonnage figures for imports for 2523 given (629,104 and 598,156 tonnes for 2019 and 2020 respectively)

For exports, we must look to the subcategories under 2523 for tonnage values (i.e. 252310, 252321, 252329, 252330, 252390) and total them (174,777 and 378,963 tonnes for 2019 and 2020 respectively).

We can now estimate a cement production figure for 2020 as consumption + exports - imports:

60,210,000 + 378,963 – 598,156 = 59,990,807 tonnes

We can now enter the calculated production figure for 2020, along with the trade figures, into the tool, as shown in table xx

A.3.8 - component used in concrete					
First, calculate domestic cement consumption (tonnes)					
		Example Data (t)		2019	2020
Cement Production (t)				55,000,000	59,990,807
Cement Imports (t)				629,104	598,156
Cement Exports (t)				174,777	378,963
Stockpile changes (t)					
Domestic cement consumption (t)				55,454,327	60,210,000
Default concrete factor	5.26				
Alternative local factor					
Factor Used	5.26				
Subtotal A.3.8 required for concrete (t)				291,689,760	316,704,600

This will calculate the expected cement consumption figure of 60,210,000 tonnes. If no *Alternative concrete factor* is entered, then *Subtotal A.3.8 required for concrete (t)* will be 316,704,600 tonnes.

Important: As cement consumption also drives a default calculation for *A.3.8 required for building sublayers* (t), an additional 25,336,368 tonnes is automatically calculated for that component. The cement production figure will also automatically drive an estimate for *A.3.2 Carbonate minerals important in cement* of 71,988,968 tonnes.

For 2019 we found a figure for cement production from the USGS link in 1). This goes to a pdf file with detailed statistics on US cement, which also has a table giving cement production for other major Global cement producers, including Brazil. There, production for Brazil in 2019 is given as 55,000,000 million tonnes, and use figures for imports and exports from Comtrade we derived above.

After entering the production, imports and exports data for 2019, The summary panel for A.3.8 Sand, gravel and crushed rock should be as shown below.

A.3.8 Sand, gravel and crushed rock					
Summary results panel					
		Example Data		2019	2020
Subtotal A.3.8 required for concrete (t)				291,689,760	316,704,600
Subtotal A.3.8 required for roads (t)				-	-
Subtotal A.3.8 required for new railway construction (t)				-	-
Subtotal A.3.8 required for building sublayers (t)				23,335,181	25,336,368
Total A.3.8.2 Sand, gravel and crushed rock for construction (t)				315,024,941	342,040,968

2. *A.3.8 Roads component exercise.*

Example

Construct an estimate of the Sand and gravel required to for road construction and maintenance for the year 2020, using the appropriate tool on the Questionnaire, for the scenario below:

You have found national level data, from whatever sources were available, which enabled you to assemble something like table xx for a country's road system.

Road Classification	New Construction in 2020 (lane km)	Existing network in 2020 (lane km)	Estimated lane width (m)
Class1	20	800	4
Class2	50	4,000	3.5
Class3	80	5,000	3.5
Class4	80	8,000	4

You have also found documents with isolated data points indicating that the following characteristics are representative of at least some examples of the different road classes.

Road Classification	Asphalt concrete (mm)	Concrete (mm)	Gravel (mm)	Rammed Earth (mm)
Class 1	70	100	70	NA
Class 2	60	NA	150	NA
Class 3	30	NA	100	NA
Class 4	NA	NA	30	NA

Solution

Firstly, convert the lane km to the km.m units used in the *A.3.8 - component used in road construction and maintenance* section of tool. Simply by applying the estimated lane width to the lane lengths gives us the fifth and sixth columns in table xx:

Road Classification	New Construction in 2020 (lane km)	Existing network in 2020 (lane km)	Estimated lane width (m)	New Construction in 2020 (km.m)	Existing network in 2020 (km.m)
Class1	20	800	4	80	3,200
Class2	50	4,000	3.5	175	14,000
Class3	80	5,000	3.5	280	17,500
Class4	80	8,000	4	320	32,000

We now try to place each class of road within the scheme of roads provided in the figure from Miatto (2017), provided on The Questionnaire's "Non-metallic minerals tools" sheet, and copied again below.

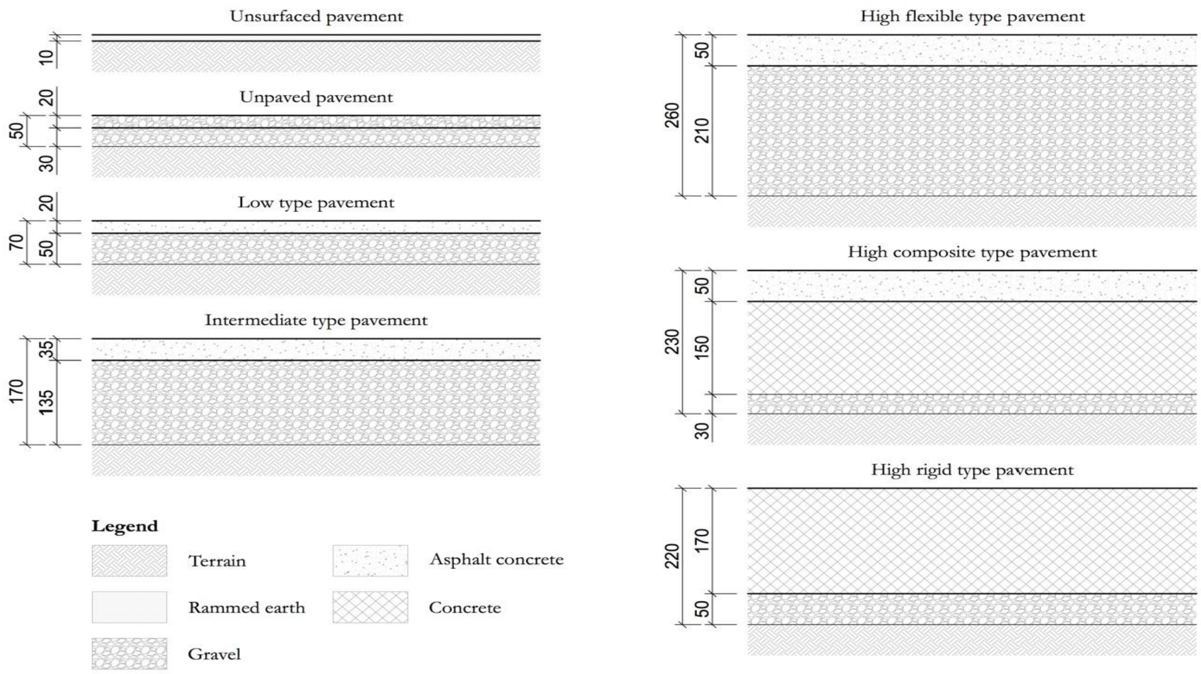

Figure xx, from The Questionnaire's "Non-metallic minerals tools" sheet.

None of the classes in table xx fit exactly with any of the profiles given in figure xx, which is likely to be the real case. You are just trying to get the most reasonable match you can. In this case, the best matches are something like.

Class1 -> High Composite type

Class2 -> High Flexible type

Class3 -> Intermediate type

Class4 -> Unpaved

At this point you can fill out the tool on the Questionnaire as shown below:

New Road Construction		**Example Data**		2019	2020
Unsurfaced pavement (km.m)					
Unpaved pavement (km.m)					320
Low type pavement (km.m)					
Intermediate type pavement (km.m)					280
High flexible type pavement (km.m)					50
High composite type pavement (km.m)					175
High rigid type pavement (km.m)					
Total Road Network (for maintanence)				2019	2020
Unsurfaced pavement (km.m)					
Unpaved pavement (km.m)					32,000
Low type pavement (km.m)					
Intermediate type pavement (km.m)					17,500
High flexible type pavement (km.m)					14,000
High composite type pavement (km.m)					3,200
High rigid type pavement (km.m)					

The calculations required are performed automatically for the next panel in the tool, which should look now as shown in table xx

New Road Construction by class	tonnes per km.m	Example Estimates (t)		2019	2020
Unsurfaced pavement (tonnes)	0	-		-	-
Unpaved pavement (tonnes)	84	-		-	26,880
Low type pavement (tonnes)	118	-		-	-
Intermediate type pavement (tonnes)	287	-		-	80,360
High flexible type pavement (tonnes)	439	-		-	21,950
High composite type pavement (tonnes)	416	-		-	72,800
High rigid type pavement (tonnes)	402	-		-	-

Road Network for maintanence by class		Example Estimates (t)		2019	2020
Unsurfaced pavement (tonnes)	0	-		-	-
Unpaved pavement (tonnes)	34	-		-	1,088,000
Low type pavement (tonnes)	34	-		-	-
Intermediate type pavement (tonnes)	60	-		-	1,050,000
High flexible type pavement (tonnes)	86	-		-	1,204,000
High composite type pavement (tonnes)	51	-		-	163,200
High rigid type pavement (tonnes)	318	-		-	-

The summary panel for A.3.8 Sand, gravel and crushed rock should now be as shown below.

A.3.8 Sand, gravel and crushed rock

Summary results panel

		Example Data		2019	2020
Subtotal A.3.8 required for concrete (t)				291,689,760	316,704,600
Subtotal A.3.8 required for roads (t)				-	3,707,190
Subtotal A.3.8 required for new railway construction (t)				-	-
Subtotal A.3.8 required for building sublayers (t)				23,335,181	25,336,368
Total A.3.8.2 Sand, gravel and crushed rock for construction (t)				315,024,941	345,748,158

3. A.3.8 Railways component exercise.

Example

Construct an estimate of the Sand and gravel required to for railway construction for the year 2020, using the appropriate tool on the Questionnaire, for the scenario below:

You have found national level data from whatever sources were available, which indicates that 15km of a 0.75m narrow-gauge railway, and 7km of standard gauge (1.435m) railway was constructed in 2020. That is all the data on railways you found.

Solution

As the standard gauge railway already has a default value for A.3.6 required per km in the tool, you would simply enter the 7km into the relevant field in the tool.

The 15km of narrow gauge, on the other hand, is of a different width to the narrow gauge pre-filled on the tool, and so we should try to adjust for this.

Firstly, we should put the 15km under "Gauge class 4" rather than one of the pre-defined gauge categories. A simple and transparent way to estimate the A.3.8 required for a 0.75m gauge railway is to assume it varies linearly with width. Using the three pre-defined gauges with their tonnes/km data, we can use the "FORECAST.LINEAR" tool in excel to derive an estimate of 1008 tonnes/km for a 0.75m railway, and enter that into the "Alternative factors (tonne/km)" field for "Gauge class 4".

The relevant section of the tool as filled in for this exercise is shown in table xx, with the values you needed to fill in shown here in red-bold font.

	Gauge (in metres)	**A.3.8 to construct (tonnes/km)**	*Alternative factors (tonnes/km)*		
Gauge class 1	0.66	818			
Gauge class 2	1.435	2,460			
Gauge class 3	1.88	3,403			
Gauge class 4	**0.75**	1,008	***1,008***		
Gauge class 5		-			

New railway constructed by Gauge class	**A.3.8 (tonnes/km)**	**Example Data (km)**		2019	2020
Gauge class 1	818				
Gauge class 2	2,460				**7**
Gauge class 3	3,403				
Gauge class 4	1,008				**15**
Gauge class 5	-				

A.3.8 Required for New railway construction, by Gauge class		**Example Estimates (t)**		2019	2020
Gauge class 1		-		-	-
Gauge class 2		-		-	17,220
Gauge class 3		-		-	-
Gauge class 4		-		-	15,120
Gauge class 5		-		-	-
Subtotal A.3.8 required for railway construction (tonnes)		-		-	32,340

The summary panel for A.3.8 Sand, gravel and crushed rock should now be as shown below.

A.3.8 Sand, gravel and crushed rock					
Summary results panel					
		Example Data		**2019**	**2020**
Subtotal A.3.8 required for concrete (t)				291,689,760	316,704,600
Subtotal A.3.8 required for roads (t)				-	3,707,190
Subtotal A.3.8 required for new railway construction (t)				-	32,340
Subtotal A.3.8 required for building sublayers (t)				23,335,181	25,336,368
Total A.3.8.2 Sand, gravel and crushed rock for construction (t)				315,024,941	345,780,498

4. *A.3.8 Building sublayers component exercise.*

Example

Estimate the Sand and gravel required to for building sublayers for the years 2019 and 2020, using the appropriate tool on the Questionnaire, for the scenario below:

Your office already collects data on m2 of annual new building floorspace construction, specified by four main building types. This is shown in table xx

From National Statistics		
Building type	**M^2 constructed 2019**	**M^2 constructed 2020**
Free-standing houses	8,000,000	8,000,000
Medium density dwellings	12,000,000	13,000,000
Multi-floor apartment (>3 storey)	10,000,000	13,000,000
Commercial/office building low rise	750,000	500,000
Commercial/office building 3+ floors	300,000	200,000

You consul with the civil engineering department of a major national university, and they have provided you with estimates of A.3.8 required for foundation sub-layers, per m2 of building floorspace, for three major building types in your country. This is shown in table xx

From University Civil Engineering Dept.	
Building type	**Sand and gravel (tonnes per m2)**
Free-standing house	0.0
Commercial low rise	0.3
Highrise buildings (>3 floors)	2.4

Solution

From the