

Chapter 7

Civil Engineering Standard Method of Measurement

The Civil Engineering Standard Method of Measurement (CESMM)¹ is now in its fourth edition, published in 2012, and this has retained the benefits of previous editions whilst bringing the document up to date and broadening its appeal both to UK users and to the international construction market.

CESMM4 is approved by its sponsors – the Institution of Civil Engineers and the Civil Engineering Contractors Association – *for use in works of civil engineering construction and may be used with any conditions of contract for civil engineering work that includes measurement* (CESMM4 – Preface).

This needs to be read in conjunction with General Principles 2.1 and 2.2 which state that CESMM4 is also intended to include *simple building works incidental to civil engineering works* (see also Class Z).

Previous editions of CESMM were closely aligned with the ICE Conditions of Contract (now the Infrastructure Conditions of Contract (ICC) – Measurement Version), but the latest edition represents a significant departure from this arrangement to the effect that CESMM4 is now:

- Contract neutral.
- (Largely) National standard neutral.

7.1 Contract neutral

Unlike CESMM3, CESMM4 may be used in conjunction with any form of contract without amendment or any contractual arrangement that includes quantities or approximate quantities or requires the work to be measured at some point. This could include:

- Lump sum contracts where any increase or decrease in the actual quantities is treated as a variation.
- Measure and value (admeasurement) contracts where the final quantities are determined on completion of the work.
- Target contracts where a priced bill of quantities is used to establish the ‘target’ price which is then compared to actual cost in order to determine the eventual pain/gain or profit share, if any.

Standard forms of contract that could be used in such circumstances include:

- JCT 2011 SBC/Q and SBC/AQ.
- ICC – Measurement Version.
- NEC3 Options B and D.
- FIDIC Construction Contract or Short Form of Contract.
- Overseas ‘local’ contracts that include provision for measurement.

In order to achieve contract neutrality, CESMM4, Paragraph 5.6, requires a schedule to be included in the Preamble to the Bill of Quantities which ensures compatibility between the method of measurement and the conditions of contractor used for a particular project. The schedule is intended to provide a definition of terms used in CESMM4 in relation to the conditions of contract employed for the project (see later under Section 7.7: *Preparation of the Bill of Quantities*).

7.2 National standard neutral

In order to widen the appeal of CESMM4, reference to British Standards or other UK specifications in the completed bills of quantities has been kept to a minimum, thereby allowing other countries to use their own standards more easily. In order to do this, it is necessary to establish exactly which standards the contractor is expected to work to on the drawings and/or in the specification for the job.

There are two exceptions to this national standard neutrality principle where the drafting committee found it impossible to avoid using UK standards:

- The types of concrete mixes referred to in CESMM4 are those of the relevant British Standards.
- The specification of work items for road construction is based on the Specification for Highway Works.

Where the bill compiler wishes to use different specifications for these items, CESMM4, Paragraph 5.6, requires this information to be included in a schedule in the Preamble to the Bill of Quantities (see later under Section 7.7).

7.3 Section 1: Definitions

Changes from CESMM3

- References to the ICE Conditions of Contract, numbered clauses and British Standards have been omitted
- Now refers to *contract administrator* and not *the engineer* (Paragraph 1.3)
- *The contract administrator may be the employer, his agent or representative*

Important definitions are contained in CESMM4 Section 1: *Definitions* including:

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| 1.2 Work | This includes <i>work to be carried out, goods, materials and services to be supplied, and the liabilities, obligations and risks to be undertaken by the contractor under the contract.</i> |
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The word ‘work’ used in CESMM4 is not to be confused with the word ‘Works’ used in the conditions of contract (e.g. Infrastructure Conditions, NEC3 or JCT). ‘Work’ relates to the effort and resources expended, and the risks and responsibilities undertaken, by the contractor in order to complete the structure or physical asset described in the contract (the ‘Works’). The reason for the distinction is that the method of measurement describes *work commonly encountered in civil engineering* (CESMM4 Paragraph 3.1), and under the contract, the contractor is responsible for delivering the ‘Works’ on or before the completion date.

1.4	Expressly required	<i>This expression means shown on the drawings, described in the specification or instructed by the contract administrator pursuant to the contract.</i>
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The importance of this phrase is that the contractor will only be paid for work that falls within the definition. Therefore, if sheet piling is required, but is not indicated on the drawings or otherwise specified, the contractor will not be paid for the work unless the contract administrator specifically instructs its use during the contract.

CESMM4 Paragraph 2.6 states that *all work which is expressly required should be covered in the Bill of Quantities*, and so, if the design requires the use of sheet piling, even if only as temporary works, it must be measured and paid for.

1.5	Bill of quantities	<i>A list of items giving brief identifying descriptions and estimated quantities of the work comprised in a contract.</i>
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This definition emphasises that the BQ does not determine the kind or quality of work required in a contract; it is the drawings and specification that do this job. The bill of quantities merely describes the work involved and provides an estimated quantity for the contractor to price having taken into account the detail stated in these other documents. This is to be contrasted with other contracts (e.g. JCT 2011 SBC/Q) where the Contract Bills do describe the nature or extent of the works required.

1.6	Daywork	<i>...The method of valuing work on the basis of time spent by the operatives, the materials used and the plant employed.</i>
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Daywork is work that may have to be measured and valued at some point in a contract but cannot be determined at the outset. It is not defined on the drawings or in the specification but may be *expressly required* by the contract administrator who will issue specific instructions for this work to be carried out.

1.8	Original surface	<i>...The surface of the ground before any work is carried out.</i>
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CESMM4 refers to surfaces rather than levels in order to describe where work, such as excavation, commences and finishes (c.f. NRM2). Before any work is started, the ‘original surface’ is what can be seen in its undisturbed state (see Figure 7.1).

1.9	Final surface	<i>...The surface indicated on the drawings to which excavation is to be carried out.</i>
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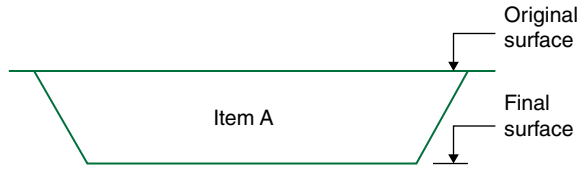


Figure 7.1 CESMM surfaces – 1.

The ‘final surface’ indicates where excavation work is to finish. Any excavation work below this surface is likely to be for the removal of unsuitable material such as soft spots or contamination (see Figure 7.1).

1.10 **Commencing surface**

1.11 **Excavated surface**

The definitions of 1.10, *Commencing surface*, and 1.11, *Excavated surface*, are each in two parts, the first of which is straightforward to follow.

1.10	Commencing surface	<i>...In relation to an item in a Bill of Quantities, the surface of the ground before any work covered by the item has been carried out.</i>
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In this case, the definition refers to the surface at which work in relation to the item begins. This could be the original surface or the excavated surface of a preceding item(s) of work.

Figure 7.2 illustrates that the commencing surface may be stated:

- a) In relation to specific items (A, general excavation; B, pile caps; C, ground anchors; and D, piles).
- b) In relation to a change in ground conditions (e.g. top of rock strata).

1.11	Excavated surface	<i>...In relation to an item in a Bill of Quantities, the surface to which excavation included in the work covered by the items is to be carried out.</i>
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Here, the definition refers to the surface at which work in relation to the item ends. This could be an intermediate surface if there is further excavation to follow, or it could be the final surface. This is illustrated in Figure 7.2.

The second parts of the definitions of 1.10, *Commencing surface*, and 1.11, *Excavated surface*, are less easy to follow.

1.10	Commencing surface	<i>...In relation to a group of items in a Bill of Quantities, for work in different materials in an excavation or a bored, drilled or driven hole, the surface of the ground before any work covered by any item in the group has been carried out.</i>
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1.11	Excavated surface	<i>...In relation to a group of items in a Bill of Quantities, for excavation in different materials, the surface to which excavation included in the work covered by any item in the group is to be carried out.</i>
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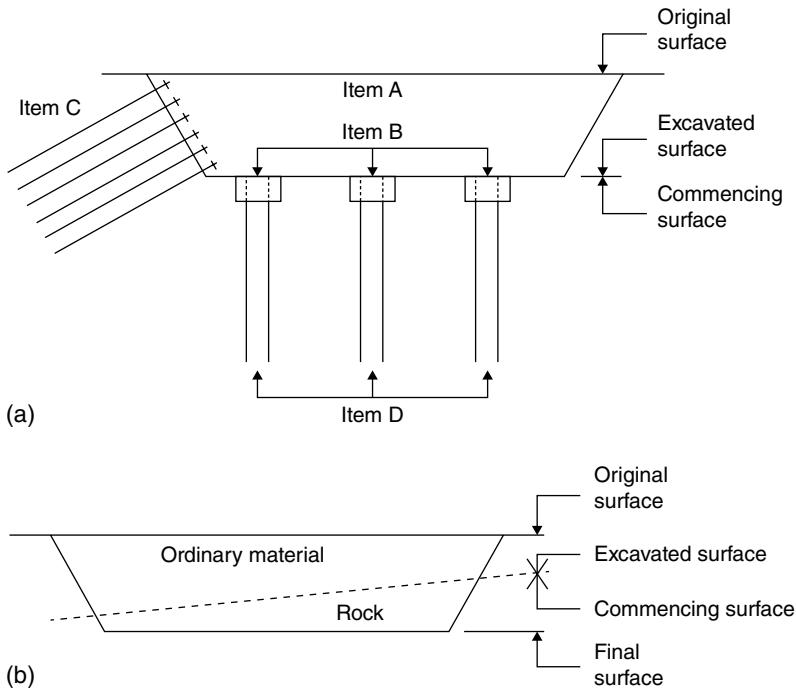


Figure 7.2 CESMM surfaces – 2. (a) Surfaces relating to items of work and (b) surfaces relating to ground conditions.

Evidently, the commencing surface is where the work relating to any item in the group starts, and the excavated surface is the point where the work relating to any item in the group ends.

The commencing surface for a diaphragm wall, therefore, is the surface where the preliminary trench and guide walls start and not where the diaphragm wall excavation starts which will normally be at a lower level. There is no distinction, therefore, between the first two items which will be carried out by a normal excavator and the excavation carried out by the diaphragm walling rig. Similarly, the excavated surface will be the bottom of the diaphragm wall.

Where the two definitions refer to a group of items in a Bill of Quantities, this phrase is not defined in CESMM4 and could therefore mean:

- Any group of items in a BQ defined by the bill compiler (e.g. a group of drainage items under Class I: *Pipework – Pipes* comprising the same pipe specification and diameter in the same location but with different depths to invert).
- A specific group of items in a BQ defined by the CESMM4 classification tables (e.g. Class C: *Diaphragm walls* consisting of guide walls, excavation, concrete, rebar, etc.).

The reference to *work in different materials* is emphasising that different commencing and excavated surfaces do not have to be specified where excavation or drilling is passing through different types of ground. In a diaphragm wall excavation, therefore, it is not necessary to state where rock excavation (if any) commences or finishes albeit that, if there is rock to be excavated, this still has to be measured.

The phrase *in an excavation or a bored, drilled or driven hole* means that the definition of commencing surface refers to:

- Any type of excavation which could be to a diaphragm wall, cutting, foundation, general excavation or a trench, etc.
- Work that is not in an excavation but is a bored hole (e.g. bored pile), a drilled hole (e.g. a ground/rock anchor) or a driven hole (e.g. a driven pile or where pipes are driven into the ground (i.e. not drilled) in order to facilitate grouting).

It should be noted that the definition of ‘excavated surface’ refers only to excavation and not to boring, drilling or driving. This is common sense because there could be additional excavation beyond an excavated surface but not in the case of a bored, drilled or driven hole which, in each case, will only have a final surface for obvious reasons.

7.4 Section 2: General principles

Changes from CESMM3

None

7.4.1 Title application and extent

Paragraph 2.1 explains that CESMM4 is the ‘official’ abbreviation to use and that the method of measurement is intended for civil engineering works and simple building works incidental to civil engineering work.

In the CESMM, *simple building works* means just that – simple! Foundations, walls, floors and even roofing could be measured using CESMM4, and there is provision for items such as joinery, doors, windows, plastering, simple building services and the like. Where there is a need for anything more complex, the bill compiler has a number of choices:

Alternative 1

Include a provisional sum in the bill of quantities in respect of the building works required (CESMM4, Paragraph 5.18).

Alternative 2

Measure the building work in a separate bill (e.g. called ‘building works’) in the bill of quantities using an alternative method of measurement (CESMM4, Paragraph 5.4, refers).

Alternative 3

Consider a procurement method more suited to multifaceted work than a traditional engineer-designed single contract.

When it comes to a £50 million railway station refurbishment in a large city centre, comprising complex roof replacement, giant atrium, refurbished platforms, enlargement of pedestrian concourses handling 150 000 passengers per day, 15 lifts and 30 escalators, CESMM4 would clearly be inadequate to deal with the building work involved with the civil engineering elements of such a project.

With a traditional procurement route, such a project would cause considerable problems for the bill compiler.

Risk issue

Alternative 1

The problem with any provisional work to be undertaken by the contractor is establishing the correct rate for valuing the work when it is carried out.

It is very likely that there will be no analogous rates in the bill of quantities, and so rates will have to be negotiated in order to establish the value of the work in progress. These will not be competitive market rates, and thus, the employer will be paying a premium for this work.

Alternatively, the contractor could be asked to supply a quotation for the work albeit that this would not be in competition either.

Alternative 2

The Preamble to the Bill of Quantities will have to state which method of measurement has been used to prepare the quantities (e.g. SMM7, NRM2, etc.) and any amendments thereto (if any).

In this case, careful attention will have to be paid to the Appendix to the conditions of contract or the Contract Data (NEC3) which normally state that only one method of measurement shall apply to the contract. If this issue is not addressed, the problem will be that the bill of quantities will contain quantities that have not been measured in accordance with the method of measurement stated in the contract.

Alternative 3

Framework contract

The civil engineering and building work content could be separated into individual work packages and tendered separately within the framework. Each work package could utilise the same form of contract if desired, but the stated method of measurement would be CESMM4 and SMM7/NRM2, respectively. For a very large contract, there could be a number of such discrete packages.

For this procurement arrangement, it would be advisable to appoint a construction manager to manage the interface between the packages. This could be either the civils package contractor or the building package contractor depending upon the respective size/importance of the packages. Alternatively, a separate managing contractor could be appointed; this would be a necessary appointment for a very large project. In any event, a principal contractor would have to be appointed to undertake the statutory CDM role which could be one of the contractors or, possibly, the employer.

Management contract or construction management

Separate work packages could be devised for the civil engineering and building work using the most appropriate form of contract and method of measurement for each package. The packages would be coordinated by the management contractor/construction manager who could also be appointed to the CDM role unless undertaken by the employer.

Design and build

The risk would no longer reside with the employer as it would be the contractor's decision as to how the work would be carried out/subcontracted. In this case, each work package could be let using any number of different subcontract forms along with the appropriate method of measurement.

7.4.2 Object of CESMM4

It would be easy to skip over this small paragraph in CESMM4. It looks quite innocuous but is, in fact, there for good and sufficient reasons.

Paragraph 2.3 establishes two facts concerning the object of CESMM4 which *is to set forth the procedure according to which*:

1. *The Bill of Quantities shall be prepared and priced and*
2. *the quantities of work expressed and measured.*

Despite being poorly phrased, this paragraph emphasises that, where CESMM4 is stated as the method of measurement in the contract:

- The Bill of Quantities shall have been prepared in accordance therewith.
- The contractor's pricing of the Bill of Quantities will be construed as being in accordance with the relevant provisions of the method of measurement as regards:
 - What the contractor has included in a particular rate irrespective of the actual pricing.
 - How general items and method-related charges, etc. have been priced irrespective of how the contractor has actually priced these items.
- The quantities of work in the Bill of Quantities shall be described in accordance with the method of measurement.
- The quantities of work in the Bill of Quantities shall be measured in accordance with the rules in the method of measurement.

Risk issue

Failure to describe or measure items in accordance with CESMM4 is technically a breach of contract but may not be sufficiently important so as to go to the root of the contract. Nevertheless, any deviation from CESMM4 in the bill of quantities must be dealt with in accordance with the provisions of the contract, and where there is no such provision, a claim for damages may be valid.

The valuation of work in progress and the valuation of variations shall be based on the item descriptions and item coverage rules as expressed in the method of measurement irrespective of how the contractor has actually priced the items. Therefore, an item of excavation shall be deemed to include an appropriate allowance for working space and earthwork support notwithstanding that the contractor may have priced such work elsewhere in the bill of quantities.

7.4.3 Objects of the bill of quantities

Paragraphs 2.4 and 2.5 emphasise the importance of the Bill of Quantities with regard to the financial control of civil engineering projects with the proviso that the BQ should be *as simple and brief as possible*.

All work *expressly required* should be included in the Bill of Quantities (Paragraph 2.6) but only to the extent that it is required to be measured by the provisions of CESMM4.

Risk issue

Where work is included on the drawings or in the specification, then it is *expressly required* and must be measured in the bill of quantities. Where work is not *expressly required* but is nevertheless indispensable for the technical realisation and the safe execution of the design, then the contractor has to allow for such work in his rates and prices.

In this regard, the contractor must be fully aware of the item coverage rules in CESMM4 because this is where work that is indispensable but not expressly required is to be found.

Paragraph 2.7 states that it is the Work Classification system of CESMM4 that determines the successful realisation of the objects of the Bill of Quantities.

7.5 Section 3: Application of the work classification

Changes from CESMM3

- Reference to BS 4449 omitted (Paragraph 3.3)

Section 3 is more than explanatory, and the use of the word *shall* in Paragraphs 3.1–3.6 and 3.9 and 3.10 elevates these paragraphs to the status of rules to be followed. Paragraph 3.3 (final paragraph) is advisory (*should*), and the remaining paragraphs (3.7, 3.8 and 3.11) are explanatory.

7.5.1 Item descriptions

Section 3 of CESMM4 explains how the Work Classification is to be applied. This is the heart of CESMM4 where *work commonly encountered in civil engineering contracts* is arranged into 26 ‘classes’ A–Z.

Class A: *General items* deals with items commonly known as ‘preliminaries’, and Classes B–Z represent items of work to be measured. Paragraph 3.1 goes on to explain how each class is arranged, and this is illustrated in Table 7.1.

7.5.2 Mode of description

In Paragraphs 3.1 and 3.4, the rule is that work item descriptions shall be made up of one descriptive feature from each of the three divisions. This enables work items to be kept short and succinct, and this is emphasised in Paragraph 3.2 which states that *item descriptions for permanent works shall generally identify the component of the works and not the tasks to be carried out*.

As a consequence, unnecessary embellishment of descriptions is avoided so that an item such as *formwork, fair finish, plane vertical, width exceeding 1.22 m* is kept free of phrases such as ‘make, erect and strike’ which is a task as opposed to a component of the Works.

Inexplicably, this rule is repeated in Paragraph 3.3 but using the less emphatic word *should* for some unknown reason.

It should be noted that there is no rule in CESMM4 that requires the bill compiler to use the phraseology of the Work Classification so long as work item descriptions comply with Paragraph 3.1 and are kept brief in accordance with Paragraph 3.3.

7.5.3 Separate items

The items included in a bill of quantities should be individual and discrete, and in this regard, CESMM4, Paragraph 3.4, requires that each item *shall* exhibit no more than one descriptive feature from each of the three divisions of the Work Classification.

This requirement ties in with the item coding and numbering protocols in Section 4.

7.5.4 Units of measurement

The Work Classification determines the unit of measurement that shall apply to each item. The units of measurement are to be found variously in divisions one, two and three, but the rule in

Table 7.1 Work classification.

Left-hand page		Right-hand page				
First division	Second division	Third division	Measurement rules	Definition rules	Coverage rules	Additional description rules
<ul style="list-style-type: none"> Each division has up to eight descriptive features Each BQ item is made up of one descriptive feature from each division 			Rules dealing with how work items should be measured	Rules that provide an explanation of words and phrases used in the work classification and in the BQ	Rules that define what is deemed to be included in an item of measured work	Rules that determine how an item of work should be described in addition to the descriptive features required in the first, second and third divisions
Example						
Class j: Pipework – fittings and valves						
Type of pipe e.g. Concrete pipe fittings	Type of fitting e.g. Bends	Diameter of pipe e.g. 200–300 mm	M1 Pipe fittings comprising backdrops to manholes shall be included in the items for manholes measured in Class K	D2 A <i>straight special</i> is a length of pipe either cut to length or made to order	C3 Items for <i>straight specials</i> shall be deemed to include cutting	A4 <i>Fittings</i> to pipework not in trenches shall be so described

Paragraph 3.5 nevertheless limits the units used to those stated in the Work Classification irrespective of which division they appear in.

The unit of measurement attached to a descriptive feature *shall* apply to all items wherein that particular descriptive feature appears.

7.5.5 Measurement rules

The right-hand page of the Work Classification is where the various rules needed to measure and describe civil engineering work are to be found. Included therein are ‘measurement rules’.

The measurement rules set out:

- *The conditions under which work shall be measured.*
- *The method by which the quantities shall be computed.*

This is where rules are to be found that govern what is to be measured or not measured in particular circumstances. For instance, Class G: *Concrete ancillaries* Measurement Rule M1 states that an item of *formwork shall be measured for surfaces of in situ concrete which require temporary support during casting unless otherwise stated in CESMM*.

The measurement rules also state how the quantities are to be calculated. For example, Class G: *Concrete ancillaries* Measurement Rule M7 says that *the mass of steel reinforcement shall be taken as 0.785 kg/m for each 100 mm² of cross section (7.85 t/m³)*.

Therefore, a 4 m length of 20 mm diameter rebar shall be deemed to weigh:

$$\begin{aligned} 0.785 \times \pi R^2 \times \text{length} &= 0.785 \times 3.142 \times 10^2 \times 4 \text{ m} \\ &= 986.59 \text{ kg} \\ &= \mathbf{0.99 \text{ tonne}} \end{aligned}$$

This is irrespective of what the rebar actually weighs.

7.5.6 Definition rules

Some of the words and phrases used in the CESMM4 Work Classification in relation to certain classes of work require clarification to be universally and unequivocally understood.

This is the role of the ‘definition rules’ which help the bill compiler to understand the extent and limits of such work when using the Work Classification and also help the estimator and other users of the bill of quantities that results from the measurement process.

For example, ‘diaphragm walls’ is an expression used in the Class C: *Geotechnical and other specialist processes* of the Work Classification wherein Definition Rule D2 explains that:

Diaphragm walls are walls constructed using bentonite slurry or other support fluids.

Consequently, if a wall is to be constructed in any other way it is not a diaphragm wall and so, when the expression ‘diaphragm walls’ appears in the bill of quantities, everyone has a clear understanding of what is meant thanks to Definition Rule D2.

Another example may be taken from Class G: *Concrete ancillaries* where Definition Rule D2 states that:

Formwork shall be deemed to be for plane areas and to exceed 1.22 m wide, unless otherwise stated.

This means that formwork shall be assumed to be flat (i.e. not curved) and wider than a standard sheet of plywood even though it might be vertical, horizontal, sloping or battered. As a result of the definition rule, the word ‘formwork’ has a clear meaning unless there is some other statement to the contrary.

7.5.7 Coverage rules

The idea behind CESMM4 is to create a bill of quantities that can be useful for the cost management of civil engineering projects whilst at the same time providing a simple and succinct document containing enough detail to enable contractors to price the work correctly, when read in conjunction with the drawings and specification.

Inevitably, the price of succinctness is a reduction in the number of measured items in the BQ which, to comprehensively cover all the work required, need to include work that is necessary but not measured. As a result, the coverage rules play an important role in clarifying what is deemed included in specific items where there might otherwise be doubt.

In this regard, it should be noted from CESMM4, Paragraph 3.8, that *a coverage rule*:

- *Does not state all the work covered by an item.*
- *Does not preclude any of the work stated being covered by a Method-Related Charge.*

Coverage rules do not necessarily define everything that might be required in an item of work because:

- Some coverage rules appear above the double line in the CESMM4 Work Classification and therefore apply to all items in a particular class of work; these general coverage rules have to be read in conjunction with the specific coverage rules that apply to individual classes of work.
- *The exact nature and extent of the work is to be ascertained from the Drawings, Specification and Conditions of Contract, as the case may be, read in conjunction with the Work Classification (CESMM4, Paragraph 5.12).*
- All work that is *expressly required* is shown on the drawings, described in the specification or instructed by the contract administrator, and it should be clear from this as to what work the contractor needs to carry out.
- The conditions of contract may further define the contractor's general obligations with regard to the provision of resources, whether temporary or permanent, *as far as they may be reasonably inferred from the Contract* (e.g. ICC – Measurement Version Clause 8).
- The conditions of contract may state that *the contractor shall be deemed to have satisfied himself as to the correctness and sufficiency of the Accepted Contract Amount* which, unless otherwise stated, is deemed to include *all things necessary for the proper execution and completion of the Works* (FIDIC Red Book Clause 4.11).
- Admittedly, on a narrow construction, English common law provides that the contractor will supply everything that is *indispensably necessary* to complete a project even though it might not be measured or specified.

Even though a coverage rule for a class of work states what is deemed included in that class of work, coverage of the work required for a particular item(s) is not necessarily confined to the measured item as it may be the case that the whole or part of that class of work is included as a method-related item in Class A: *General items*.

The possibility that some or all of the work deemed included in a measured item by virtue of a coverage rule is actually priced elsewhere is anticipated in Paragraph 3.8. This possibility would have to be taken into account when it comes to the re-evaluation of BQ rates or the valuation of variations to the contract.

7.5.8 Additional description rules

The nature of methods of measurement and the process of building item descriptions do not represent a precise science, and it is easy for the bill compiler to unconsciously misrepresent an item of work such that the contractor's estimator is left 'in the dark' as to its meaning.

Even when the method of measurement is followed faithfully, there are occasions when judgement suggests that more information is required to describe an item fully, and this eventuality is anticipated by CESMM4, Paragraph 3.9. This allows for more description to be given than is required in Paragraph 3.1 *where required by any provision of Section 5 of CESMM4 or by any applicable additional description rule in the Work Classification.*

Paragraph 3.9 also says that *where additional description is given, a separate item shall be given for each component of work exhibiting a different additional feature.* Therefore, where the composition and materials of bridge bearings of similar type are different, separate items shall be given in accordance with *Additional Description Rule A3 of Class N: Miscellaneous metalwork.*

Notwithstanding the provisions of Paragraph 3.9, Paragraph 5.14 also says that additional description shall be given where strict application of the Work Classification would be inadequate.

Following CESMM4, Paragraph 3.10, additional description rules are sometimes used to override the requirements of a descriptive feature of the Work Classification.

Therefore, the nominal bores of pipes in **CLASS I: PIPEWORK – PIPES** shall be given in the item description instead of the range given in the **SECOND DIVISION** following the requirement of **ADDITIONAL DESCRIPTION RULE A2**. This is shown in Table 7.2.

Table 7.2 Additional description rules.

FIRST DIVISION		SECOND DIVISION		THIRD DIVISION	
1	Clay pipes	1	Nominal bore: not exceeding 200 mm	1	Not in trenches
2	Concrete pipes	2	200-300 mm	2	In trenches, depth: Not exceeding 1.5 m
3	Iron pipes	3	300-600 mm	3	1.5-2 m
4	Steel pipes	4	600-900 mm	4	2-2.5 m
5	Polyvinyl chloride pipes	5	900-1200 mm	5	2.5-3 m
6	Glass reinforced plastic pipes	6	1200-1500 mm	6	3-3.5 m
7	High density polyethylene pipes	7	1500-1800 mm	7	3.5-4 m
8	Medium density polyethylene pipes	8	Exceeding 1800 mm	8	exceeding 4 m

MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	ADDITIONAL DESCRIPTION RULES
			A2 The materials, joint types, nominal bores and lining requirements of pipes shall be stated in item descriptions.

EXAMPLE	
Ref	Item
E224	Concrete pipes; 225 mm diameter; In trenches depth 2-2.5 m

Similarly, the nominal thickness of walls in **CLASS U: BRICKWORK AND MASONRY** shall be given instead of the range listed in the **SECOND DIVISION**.

7.5.9 Applicability of rules

Albeit not a rule in itself, Paragraph 3.11 is nevertheless important because it states that rules printed above a double line on the right-hand page of the Work Classification apply to all items in the class.

Rules printed below the double line only apply to the groups of items that appear on the left-hand page within the corresponding single horizontal lines when read across right to left.

7.6 Section 4: Coding and numbering of items

Changes from CESMM3

None

Section 4 of CESMM4 provides a simple to follow item numbering system that can be used to:

- Create unique reference codes for all measured items.
- Code measured items where there is no appropriate feature in the Work Classification.
- Code measured items where there is no applicable division in the Work Classification.
- Provide a unique code for measured items with additional descriptive features that would otherwise be indistinguishable from similar items.
- Identify individual items in the bill of quantities, if desired.

7.6.1 Coding

Paragraph 4.1 explains that the CESMM4 coding system is alphanumeric with a reference letter identifying the class of work to which the item belongs followed by up to three numbers denoting the relevant descriptive feature from each of the three divisions of the Work Classification.

Where more than one descriptive feature from any of the three divisions of the Work Classification applies to a measured item, an asterisk (*) is used (Paragraph 4.2 refers).

An example of how the coding system works is given in Figure 7.3 where it can be seen that the item of concrete pipes, nominal bore 300–600 mm, in trenches depth 1.5–2 m is coded I233 as per Class I: *Pipework – Pipes*, that is, the Class (I) followed by a code from each of the three divisions.

The item would not be billed with this description because the Class I, Additional Description Rule A2, requires the nominal bore to be given in the description (see CESMM4, Paragraph 3.10, and also Table 7.3).

Primary Code	Description	Quantity	Units	Net Rate	Net Total
I	Pipes				
I2	Concrete Pipes				
I2.030	Nominal bore: 450 mm				
I2.030.030	in trenches, depth: 1.5-2 m	124	m		

Primary Code	Description	Rate	Units	Use Code	Level
I2.030.010	not in trenches		m		3
I2.030.020	in trenches, depth not exceeding 1.5 m		m		3
I2.030.030	in trenches, depth: 1.5-2 m		m		3
I2.030.040	in trenches, depth: 2-2.5 m		m		3
I2.030.050	in trenches, depth: 2.5-3 m		m		3
I2.030.060	in trenches, depth: 3-3.5 m		m		3
I2.030.070	in trenches, depth: 3.5-4 m		m		3
I2.030.080	in trenches, depth exceeding 4 m		m		3

Figure 7.3 Coding.

Table 7.3 Billing with additional description.

	Pipes					

	<u>Concrete Pipes</u>					
	Nominal bore: 450 mm					
A	in trenches, depth: 1.5-2 m	124				

CESMM4 shows spaces rather than full stops to separate the characters in an item code except where a prefix and/or a suffix code is required. There is no rule governing this, and the choice is a personal one, so long as unique items are given a unique code when ‘taking-off’.

The use of full stops becomes important for contracts where there are several parts to the bill of quantities, or where the BQ items are to be referenced with the CESMM4 codes.

Consequently:

- Items coded I 2 3 3, which appear in more than one part of the BQ, would need to be distinguished, one from the other, by use of a **prefix** denoting the bill number (e.g. item I 2 3 3 in Bill No 3 could be coded 3.I 2 3 3).
- Where additional description is given to an item, the item code would attract a **suffix** (e.g. where an item I 2 3 3 is to be excavated by hand, additional description would be given in accordance with Additional Description Rule A7, and the item could be coded I 2 3 3.1 to distinguish it from other similar items excavated by machine).

Should both a prefix and suffix be used, an item could equally be coded as 3.I 2 2 3.1 as 3.I. 2.2.3.1, so long as both codes are unique.

7.6.2 Item numbers

Once measured items have been coded, Paragraph 4.3 provides that the same code can be used to identify the relevant item in the bill of quantities. This is purely optional and any other referencing may be used instead (e.g. the traditional page number and item letter alphanumeric code). Should the CESMM4 codes be used, the BQ items should be listed in ascending order (i.e. 1–9).

Risk issue

Paragraph 4.4 emphasises that there is no contractual significance attached to the code number used in the bill of quantities and that the code number is not part of the item description, presumably to avoid potential conflict where an item has been described correctly but coded wrongly and vice versa.

7.6.3 Coding of unclassified items

Should a measured item of work possess a feature that is not listed in the Work Classification, the feature receives the code number 9 because the maximum number of features in any division is 8 (CESMM4, Paragraph 4.5, refers).

If it arises that a division of the Work Classification does not apply to a particular item, or where there are less than three divisions that apply to the item, then the code 0 (zero) shall be applied in accordance with Paragraph 4.6.

7.6.4 Numbering of items with additional description

Where a measured item requires additional description, as prescribed by an additional description rule in the Work Classification or by Paragraph 14 of Section 5, the item in question will need to be coded in order to distinguish it from other similar items which do not have the additional descriptive feature.

Accordingly, Paragraph 4.7 requires that a suffix code is given to the item(s) in question.

In Class M: *Structural metalwork*, Additional Description Rule A6 requires that *item descriptions for erection shall separately identify and locate separate bridges and structural frames and, where appropriate, parts of bridges or frames.*

Therefore, the erection item for the steel bridge beams for two grade-separated highway bridges at an interchange would be separately identified in the take-off and in the bill of quantities as illustrated in Figure 7.4.

Part 2

Primary Code	Description	Quantity	Units	Net Rate	Net Total
M	Structural Metalwork				
M5	Erection of members for bridges				
M5.020	Permanent erection				
M5.020.010	Bridge 2A; Tarrant interchange	55.87	t		
M5.020.015	Bridge 3A; Tarrant interchange	38.80	t		

	Structural Metalwork				
	<u>Erection of members for bridges</u>				
	Permanent erection				
A	Bridge 2A; Tarrant interchange	55.87	t		
B	Bridge 3A; Tarrant interchange	38.80	t		

Figure 7.4 Coding with additional description.

In Figure 7.4, it can be seen that the Class M codes from the first and second divisions have been assigned to each bridge (there is no third division descriptive feature) and that the software has assigned a further discrete code to each item.

It should be noted that CESMM4 only requires the suffix code to be given if the bill of quantities items are to be coded with Work Classification code numbers. Therefore, the BQ items in Figure 7.4 are coded with a simple alpha code, not the CESMM code, but the items would comply with Rule A6 because each bridge is separately identified and located in the items.

The quantity take-off is coded as part of the audit trail back to the original dimensions.

7.7 Section 5: Preparation of the Bill of Quantities

Changes from CESMM3

- Method of measurement now contract and (generally) specification neutral (Paragraph 5.6)
- Schedule (of terms) to be included in the Preamble to the Bill of Quantities (Paragraph 5.6)
- Reference to a *standard schedule* instead of the FCEC Schedule of Dayworks (Paragraph 5.7)
- Provisional sums now to be for *defined work* (Paragraph 5.18)
- CESMM3, Paragraph 5.22: *Form and setting out* of the Bill of Quantities seemingly omitted in error
- There shall be *an item* for a general contingency in the Grand Summary instead of a *Provisional Sum* (Paragraph 5.25)

Section 5 of CESMM4 sets out rules to determine the structure, order and content of the bill of quantities in order that the quantification of civil engineering work based on this method of measurement may assume a uniform, consistent and familiar look.

7.7.1 Measurement of completed work

It is important to note that the measurement of completed work shall also comply with the provisions of Section 5.

Of particular significance in this regard is Paragraph 5.11 which requires that *all work shall be itemized and all the items shall be described in accordance with the Work Classification* but that *further itemization and additional description may be provided should special methods of construction or considerations of cost arise.*

Risk issue

It is clear, therefore, that the admeasurement of completed work, and the measurement of variations to the contract, shall comply with the provisions of CESMM4 and that other methods of measurement, or *ad hoc* methods, cannot be used instead.

7.7.2 Sections of the bill of quantities

In keeping with the objective to standardise presentation, Paragraph 5.2 prescribes that *the Bill of Quantities shall be divided into the following sections:*

- a) List of principal quantities.
- b) Preamble.
- c) Daywork Schedule.
- d) Work items (grouped into parts).
- e) Grand Summary.

The Daywork Schedule is optional as Paragraph 5.7 refers to the Daywork Schedule, *if any*.

7.7.3 List of principal quantities

The provision of a list of principal quantities, usually in the specification, was always fairly common prior to CESMM which has simply formalised custom and practice.

The presence of principal quantities in the bill of quantities is *solely to assist tenderers* by providing an indication of the *scale and character* of the proposed works *prior to the examination of the remainder of the Bill of Quantities and the other contractual documents on which their tenders will be based*. The list is provided in order to give the estimator, in particular, a ‘feel’ for what is involved in the project.

Risk issue

How effective this disclaimer might be in the event that the list of principal quantities creates a false impression of what is involved in the works, or proves to be misleading in terms of the contractor’s pricing of the job, might be open to question.

It is clear, nonetheless, that it is the **remainder** of the *Bill of Quantities*, along with other documentation, which forms the basis of the contractor’s tender offer and not the list of principal quantities.

The contents of the list is purely subjective – there are no rules to guide the bill compiler in determining which items to include or which items might be of most importance or significance to the contractor.

7.7.4 Preamble

The Preamble to the Bill of Quantities has three important functions:

1. To state where CESMM4 has been amended or where another method of measurement has been adopted in preparing the bill of quantities.
2. To provide a definition of rock.
3. To provide a ‘schedule’ to define terms used in CESMM4 in the context of the conditions of contract used for the project.

1. Other Methods of Measurement

Section 5, Paragraph 5.4, requires that the Preamble shall state which other methods of measurement (if any) have been used in preparing the bill of quantities. This includes amendments to CESMM4 as well as other standard methods such as SMM7 or NRM2. Consequently, where work is to be measured, and the standard version of CESMM4 is not used, this shall be stated in the Preamble.

It should be noted that, where bills of quantities are used with NEC3 (Options B and D), amendments to the chosen method of measurement are to be stated in Contract Data Part 1.

CESMM4, Paragraph 5.4, makes reference to two sets of circumstances where CESMM4 might be abbreviated:

- Contractor-designed work where the contractor is asked to design a particular part(s) of the works in accordance with stipulated employer’s requirements.
- Other circumstances such as where the contractor is given a choice between alternative construction methods.

In both cases, the bill compiler will provide items in the BQ for the contractor to price but will not use the entire extent of the CESMM4 Work Classification to do so. This will avoid being prescriptive about what the contractor is pricing and enable the contractor to make the choice as to what precisely is covered by the items in question. The BQ items provided will ensure that suitable rates are provided for admeasurement purposes and for the valuation of variations. The extent of the work affected by all amendments shall be stated in the Preamble.

Typical examples of contractor design in civil engineering include:

- Geotechnical work including ground anchors, diaphragm walls and vibroflotation.
- Piling.
- Roads and paving (highways, concrete runways, etc.).
- Rail track work.
- Sewer and water main renovation.

2. Definition of Rock

Importantly, Paragraph 5.5 requires a definition of 'rock' to be provided in the Preamble where the work includes excavation (e.g. diaphragm walls, earthworks, drainage), boring (e.g. ground anchors, bored piling) or driving (e.g. driven piles). CESMM4 is silent on the form that the definition shall take which could be:

- A geological definition of rock 'strata' making reference to borehole details supplied with the tender documents.
- A definition of rock 'deposits' where materials excavated from a designated 'zone' or part of the works (shown on the drawings) would be classed as 'rock' irrespective of the material actually found on the site.
- A definition which relates to how the material is to be removed (e.g. by using explosives, wedges, rock hammers or 'special' plant).

3. Schedule of Terms

A significant difference between CESMM3 and its successor is that CESMM4 is now contract neutral and can be used with any preferred conditions of contract. Consequently, the references that were made to the ICE Conditions of Contract in CESMM3 do not appear in CESMM4.

This means that terminology that would otherwise have been defined in the ICE Conditions of Contract, the default contract in CESMM3, must now be made explicit in the bill of quantities on the basis that different forms of contract may be used in conjunction with CESMM4 and that words and phrases used in CESMM4 may have different meanings in different forms of contract.

In order to achieve compatibility between the conditions of contract and CESMM4, Paragraph 5.6 requires that a schedule *must be* included in the Preamble listing words and phrases used in CESMM4 along with the clause number and term in the conditions of contract that defines the particular word or phrase used in CESMM4 in the language of the contract. The schedule has no specific title in CESMM4 which, presumably, the bill compiler is at liberty to choose (e.g. schedule of terms).

CESMM4 provides a *pro forma* schedule which lists CESMM4 terms that need to be cross-referenced to an appropriate clause in the conditions of contract. There is a space in the schedule for the bill compiler to insert the equivalent term and clause number from the conditions of contract so that the CESMM4 term can be understood in relation to the conditions of contract. For example, *Daywork Schedule* in CESMM4 Paragraph 5.2 is equivalent to *Shorter Schedule of Cost Components* in Clause 11.2(22) in ECC Option B.

This schedule must be replicated in the Preamble to the Bill of Quantities and may be added to as required, such as when CESMM4 is amended for any reason. Put in simple terms, the schedule provides words or phrases that can be used in place of those used in CESMM4 without creating a conflict between the method of measurement and the conditions of contract.

7.7.5 Daywork schedule

A contractual provision for payment on a Daywork basis is frequently needed on civil engineering projects so that unexpected work that cannot be valued at analogous or fair rates can be paid for on the basis of resources used (see Chapter 4).

Such a contractual provision is usually made in two places:

- In the form of contract where the principles that apply to the valuation of variations are established.
- In the bill of quantities where:
 - Provisional items are included as a contingency should payment on a daywork basis be instructed by the contract administrator.
 - Competitive daywork rates are established which are agreed by the parties and reflect the ‘going rate’ for daywork in the industry at the time of tender.

CESMM4, Paragraph 5.7, provides three methods for including a Daywork Schedule in the Preamble to the Bill of Quantities, none of which are compulsory:

1. A list of the various classes of labour and plant and types of materials is provided which each tendering contractor prices. The list is accompanied by *a statement of the conditions under which the Contractor shall be paid for work executed on a Daywork basis.*
2. A statement that the contractor will be paid Daywork in accordance with the rates and prices stated in *the standard schedule included in the contract* to which the percentages quoted by the contractor at tender stage will be added or deducted.
3. By inference, no provision for a Daywork Schedule at all – *the Daywork Schedule if any shall comprise....*

Under Option 1, the *statement of the conditions under which the Contractor shall be paid for work executed on a Daywork basis* included in the bill of quantities must reflect what is said in the conditions of contract which normally contains an express condition as to how claims and variations are to be valued. There should be no conflict between the statement and the conditions.

Under Option 2 in CESMM3, the standard schedule was the *Schedules of Daywork carried out incidental to Contract Work* issued by the Federation of Civil Engineering Contractors.² Being contract neutral, CESMM4 does not specify which, if any, standard schedule shall be used as there are several options available.

Paragraph 5.8 suggests that provisional sums *may be given* for work to be executed on a daywork basis listed under the separate headings of labour, materials, plant and other charges. Where Option 2 is used, adjustment items shall be given for each category so that tenderers may price a percentage addition/deduction to the standard schedule. The price inserted in the priced bill of quantities shall be the Provisional Sum for each category \pm the quoted percentage.

7.7.6 Work items

CESMM4, Paragraphs 5.9–5.23, concern how the main body of the bill of quantities is to be arranged and provide a small number of general rules that shall apply to work items.

Division of the bill of quantities into parts

Remembering that the bill of quantities must be divided into ‘sections’ as specified in Paragraph 5.2, and that ‘work items’ is one of those sections, places Paragraph 5.9 in the correct context. ‘Work items’ should not be confused with the ‘Work Classification’ from which the ‘work items’ may be drawn.

Paragraph 5.2 provides that the bill of quantities *may be* divided into numbered parts in order to distinguish work to be carried out in circumstances that may be *likely to give rise to different methods of construction or considerations of cost.* There is no prescription as to how this might be done, and it is the skill and judgement of the bill compiler that will dictate whether this is done well or badly. The main consideration is to help the contractor to price the work accurately, and

to programme activities realistically, without being put to the trouble and expense of isolating the quantities of work requiring special consideration.

It should be noted that Paragraph 5.9 states that items in each separate part of the Bill of Quantities *shall be arranged in the general order of the Work Classification*.

If the nature of the project has no special characteristics requiring subdivision of the Bill of Quantities into 'parts', then it may be subdivided into the applicable classes of the Work Classification. The BQ for an enabling works contract may therefore be subdivided as follows:

- Section A: List of principal quantities.
- Section B: Preamble.
- Section C: Daywork schedule.
- Section D: Work items:
 - Part 1: General items (Class A).
 - Part 2:
 - Geotechnical and other specialist processes (Class C).
 - Demolition and site clearance (Class D).
 - Earthworks (Class E).
 - Piles (Class P).
 - Piling ancillaries (Class Q).
- Section E: Grand summary.

However, a land drainage scheme, where some of the work is to be carried out in tidal conditions and where differences in location, access and construction methods characterise parts of the work, will need to be subdivided into parts because of the nature of the work entailed. In this case, each part of the BQ should be subdivided into the relevant classes of the Work Classification:

- Section A: List of principal quantities.
- Section B: Preamble.
- Section C: Daywork schedule.
- Section D: Work items:
 - Part 1: General items (Class A).
 - Part 2: Sea outfall (tidal):
 - Earthworks (Class E).
 - In situ concrete (Class F).
 - Concrete ancillaries (Class G).
 - Part 3: Drainage and headwalls:
 - Pipework – Pipes (Class I).
 - Pipework – Fittings and valves (Class J).
 - Pipework – Manholes and pipework ancillaries (Class K).
 - Etc.
 - Part 4: Drainage ditches:
 - Earthworks (Class E).
 - Precast concrete (Class H).
 - Etc.
 - Part 5: Pumping station:
 - Excavation (Class E).
 - In situ concrete.
 - Concrete ancillaries (Class G).
 - Precast concrete (Class H).
 - Etc.
- Section E: Grand summary

Other examples where work may need to be subdivided into parts include:

- Work carried out beyond the site boundary.
- Highway work – separation of main carriageway, side roads and structures.
- Airport work – separation of work carried out ‘airside’.
- Sewer work – separation of work carried out in ‘live’ sewers.

Other work will be too large and/or complex for a single bill of quantities and may require non-traditional procurement methods and contract documentation reflecting the size, complexity and contractor design input into such work:

- Rail work:
May involve station buildings as part of a city centre redevelopment scheme, new and replacement rail track work carried out under measured term contracts, under-/overbridges involving line possessions, multibillion £ electrification framework contracts.
- Power stations:
A large power station project costing several billion pounds will comprise numerous separate elements, each of which will probably be subdivided into individual contracts. Access road-works, wharves and jetties, railway works, cooling towers, heavy foundations and piling, structural steel frames, superstructures and ancillary buildings will all be significant contracts in their own right, and all will be procured via separate contracts using different procurement methods.

Should bills of quantities be considered appropriate for any element of such projects, whether supplied by the employer, by contractors or by subcontractors, and if the bills of quantities are prepared using CESMM4 as the basis for measurement, then the rules applying to the subdivision of bills of quantities will need to be followed in order to be compliant.

Headings and subheadings

Where the bill of quantities is divided into parts, Paragraph 5.10 requires that each part *shall be given a heading* and groups of items within parts *shall be given subheadings*. Care needs to be exercised in deciding what the text of these headings and subheadings will be because Paragraph 5.10 stipulates that they *shall be read as part of the item descriptions to which they apply*.

Referring to the example given Section 7.7.6 previously for a land drainage scheme, Part 3: *Drainage and headwalls* could be a heading, and *Pipework – Pipes (Class I)*, *Pipework – Fittings and valves (Class J)* and *Pipework – Manholes and pipework ancillaries (Class K)* could be subheadings.

Paragraph 5.10 also provides rules to ensure that the work included under headings and subheadings shall be clearly defined by underlining the description column and by repeating the headings and subheadings on subsequent pages of the BQ.

Extent of itemisation and description

Barnes (1977) considers that Paragraph 5.11 is one of the most important in CESMM because it allows the bill compiler the freedom to elaborate item descriptions and to separate items beyond the strict limitations of CESMM.

In order to understand this view, the words in Paragraph 5.11 merit careful attention:

- All work *shall be itemized*, and the items *shall be described* in accordance with the Work Classification.
- Further **itemization** and **additional description** *may be* provided under circumstances where *special methods of construction or considerations of cost* may arise.

However, the bill compiler has a choice if it is felt that the Work Classification is inadequate in some way and that *further itemisation and additional description* might help the contractor in particular circumstances.

Risk issue

The bill compiler has no choice but to follow the Work Classification. Therefore, provided the bill of quantities is prepared in strict accordance with the Work Classification, there can be no claim by the contractor that the work has been itemised or described incorrectly or misleadingly.

Before exploring the possibility of providing further itemisation *and* additional description, the bill compiler should scrutinise the coverage and additional description rules in the Work Classification to make sure that the issue is not already covered.

Risk issue

Provided that the additional itemisation and description is supplementary to the Work Classification, then again there is no valid claim if the contractor feels that the work has not been correctly billed.

It should be noted, however, that the word 'and' appears between *further itemisation and additional description*, not 'and/or'.

In other words, on a strict interpretation, if further itemisation is given, then additional description must also be given.

Descriptions

Paragraph 5.12 acknowledges that BQ descriptions *shall identify the work covered by the respective items* but also places the onus firmly on the contractor to ascertain *the exact nature and extent of the work* from the Drawings, Specification and Conditions of Contract, read in conjunction with the Work Classification. In effect, this means that the bill of quantities does not fully describe and accurately represent the work required but identifies it well enough that further detail may be obtained by scrutinising other documents.

Risk issue

This paragraph may have been overlooked by the review committee because it is identical to that in CESMM3 and resonates strongly with the sufficiency of tender provisions of the ICE Conditions of Contract (now ICC – Measurement Version).

The wording is also 'old fashioned' and sits awkwardly with the phraseology used in NEC3, for instance.

Care would be needed in using CESMM4 with NEC3 to make sure that such words and phrases were clearly defined in terms of the contract. The Paragraph 5.6 schedule (of terms) could be used for this purpose.

Paragraph 5.13 allows that item descriptions do not have to be fully in accordance with the Work Classification provided that any missing descriptive detail is signposted to a Drawing or Specification clause. This permits item descriptions to retain their brevity whilst, at the same time, making sure that the contractor can find the information needed for pricing in some other document.

The converse to this is Paragraph 5.14 which requires that additional description *shall be given* where application of the Work Classification does not identify individual items of work sufficiently

clearly. Such additional description shall refer to the location of the work, or to other physical features of it, that may be shown on the Drawings or be described in the Specification.

Ranges of dimensions

In some cases, the Work Classification provides a range of dimensions, one of which may be chosen as a descriptive feature of an item, for example, H 1 2 4: Precast concrete beams, length 5–7 m, mass 1–2 t.

Normally, individual items would be listed under this heading distinguished by a mark or type number, but where the precast beams are all the same size, Paragraph 5.15 permits the actual dimensions to be stated rather than the Work Classification ranges.

Prime cost items

The idea behind P C Items is to provide a sum of money in the contract bills which can be expended during the contract in order to pay for:

- Specialist work to be carried out on the site.
- Specialist work to be carried out off-site.
- Design work in connection therewith.

The sum of money included in the BQ is the estimated cost of the work which is later replaced in the final account by the actual cost.

The usual procedure is that a specialist contractor is subsequently chosen or ‘nominated’ by the employer/contract administrator and engaged as a subcontractor by the main contractor, subject to the right of reasonable objection. The nominated subcontractor is thus in direct contract with the main contractor (not the employer) who provides on-site facilities to the subcontractor. These attendances (or ‘labours’) are priced by the main contractor in the BQ against specially provided items along with an additional item for main contractor’s profit and overheads (‘other charges and profit’).

Paragraph 5.16(a)(i) explains that, where the nominated subcontractor is to carry out work on-site, ‘labours’ only include use of the main contractor’s facilities, light and power, disposal of rubbish and space for cabins, etc., whereas Paragraph 5.16(a)(ii) provides that unloading, storing and hoisting materials, etc. are included where the work is carried out off-site (i.e. where the nominated subcontractor is effectively a supplier). It should be noted that the CESMM4 definition of ‘labours’ prevails only *in the absence of any express provision in the contract to the contrary*.

Where specific rather than general attendances are required for nominated subcontract work on-site, such as material handling, crane hire, etc., it is advisable to insert a BQ item for ‘special labours’ to be priced by the main contractor.

Allowances for Prime Cost Items are to be included in General Items (Class A) which provides for *labours* and *special labours* in connection with P C Items. Rule M8 applies.

Rule A6 stipulates that the item description for P C Items shall identify the work included, and Rule A7 stipulates that the special labours required shall be stated in the item description. Table 7.4 illustrates these principles.

There is no special wording or way of describing work covered by P C Items in CESMM4.

Risk issue

It is surprising that CESMM4 retains the concept of including P C Items in the Bill of Quantities as its use is somewhat outmoded in modern-day procurement practice.

The preference nowadays appears to be for employers to avoid the risk of nomination, especially where subcontractor design is involved, and to pass this on to the contractor either via a list of ‘preferred’ subcontractors or by using full or partial contractor design.

Table 7.4 P C items – 1.

General Items				
<u>Nominated Sub-Contractors which include work on the Site</u>				
A	Prime Cost Item; Supply and install circular cast iron flap valve; 2m diameter; Fixing to RC headwall; Including fixing bolts; Estuary outfall; Tidal	sum		
B	Labours	sum		
C	Special labours; Offloading, handling and storing; Setting out; Lifting into position; Safe working platform	sum		
D	Other charges and profit	sum		

However, Paragraphs 5.16(a)(i) and (ii) make it clear that such sums may relate to work carried out off-site as well as on the site, and as such, the implication is that separate items would be provided in order to distinguish between the two situations. This is illustrated in Table 7.5.

Table 7.5 P C items – 2.

General Items				
<u>Nominated Sub-Contractors which include work on the Site</u>				
A	Prime Cost Item; Electrical installation and pumping equipment	sum		
B	Labours	sum		
C	Special labours	sum		
D	Other charges and profit	sum		
<u>Nominated Sub-Contractors which do not include work on the Site</u>				
E	Prime Cost Item; Pre-stressed concrete bridge beams	sum		
F	Labours	sum		
G	Special labours	sum		
H	Other charges and profit	sum		

In Paragraph 5.17, goods, materials or services supplied to the main contractor by a nominated subcontractor must be identified in the relevant item description or in the heading to the relevant Prime Cost Item. This would be the case, for instance, where the contractor is to fix materials supplied by the nominated subcontractor.

Risk issue

It is important to remember that the facility to nominate subcontractors must be mirrored in the conditions of contract and express provision is made for this in the ICC – Measurement Version (Clauses 58 and 59) and in FIDIC ‘Red Book’ (1999) (Clause 5).

Nomination is not, however, provided for in JCT contracts or in the NEC3.

Provisional sums

All construction projects need a contingency allowance in order to provide for the unexpected, and it is sensible to include this in the bill of quantities and provide the contract administrator with the express contractual power to spend the money, if need be. This allowance usually takes the form of a general contingency and a list of provisional items.

Paragraph 5.18, which recognises the need for such an allowance, deals specifically with Provisional Sums and distinguishes between *provisional sums for defined work* and the *general contingency* (see also Paragraph 5.25 – not 5.26 as stated in 5.18).

Defined work is where *the scope of the work cannot be completely designed* but *the scope can be defined*. Provisional sums for defined work are included in General Items (Class A.4.2), whereas, presumably, anything else will appear with or be included in the general contingency which *shall be given in the Grand Summary*. Table 7.6 provides an example of work that can be defined but cannot be designed until work commences on-site.

Table 7.6 Provisional sums.

General Items					
<u>Provisional Sums</u>					
Provisional Sums - Defined Work					
A	Excavation and disposal to create new wetland habitat for phragmites; Allow for careful removal and deposition of plants; Approximate area 1000 m ² in North East corner of site. Shape and depth of individual lagoons to be determined on site by the Engineer			sum	

Phragmites = common reed

Class A coverage rule C2 confirms that the tenderer shall be deemed to have made appropriate allowances in his General Items for the programming, planning and pricing of defined provisional work.

The quantities included in a CESMM bill of quantities are recognised as being *estimated quantities* in Section 1: *Definition 1.5*. Consequently, there is no provision in CESMM for approximate

or provisional quantities where the scope of part of the works is uncertain. The only recourse is for the bill compiler to include a provisional sum for defined work or to include an appropriate allowance in the general contingency.

This creates a problem on-site with respect to agreeing rates for provisional work or for contingency spending, and therefore, some bill compilers create bill items that may not be used, or inflate the quantities in 'legitimate' items, in order to establish rates and prices should the need arise and create a 'hidden' contingency at the same time.

Paragraph 5.18 makes the point that quantities *shall not* be increased in order to provide for contingencies. Notwithstanding this, it is common practice to do so and then, hopefully, show a saving when the work is admeasured.

Risk issue

Now that CESMM4 is contract neutral, inflating quantities could be a dangerous strategy because:

- The contract used could easily be a lump sum contract.
- There could be hidden problems with costly variations.
- There could be a clause in the contract entitling the contractor to a re-rate should the actual quantities be less than those estimated beyond a prescribed threshold.

Quantities

Paragraph 5.19 makes the usual stipulation that *quantities shall be computed net using dimensions from the Drawings* unless:

- There is a measurement rule to the contrary.
- Directed otherwise by the contract.

No allowance shall be made for bulking, shrinkage or waste, and the bill compiler is at liberty to round quantities up or down and use fractional quantities where necessary, but not to more than one place of decimals.

This paragraph should be read in conjunction with Paragraph 5.1 which states that *appropriate provisions of this section* (i.e. Section 5) *shall also apply to the measurement of completed work*.

Pursuant to Paragraphs 5.1 and 5.19, therefore, the quantities of completed work shall also be measured in the same way as those in the Bill of Quantities:

- Net.
- Using dimensions from the drawings.

Consequently, when it comes to the admeasurement of work, it is a fallacy to imagine that work shall be physically measured on-site unless there are no drawings available, revised and up to date, from which to measure.

Units of measurement

Paragraph 5.20 prosaically lists the units of measurement that shall be used with CESMM4, together with their abbreviations, which do not bear repeating here.

Work affected by water

In civil engineering work, the presence of water is frequently a major risk factor. This might be a river or stream, canal, lake or tidal water such as the sea or an estuary.

Paragraph 5.21 requires such bodies of *open water* to be identified in the Preamble whether they are on or bounding the site. Also, they *shall be* referenced to a drawing where the boundaries and surface level of such bodies of open water are indicated. Where the boundaries and surface levels fluctuate, the range of fluctuation *shall* also be indicated which Barnes (1977) considers should be the mean low and high water levels (ordinary spring tides) of the surface of tidal waters.

The presence of groundwater is excluded from the Paragraph 5.21 requirements, and Barnes (1977) considers that there are difficulties in distinguishing everything that will be affected by water. He also considers that the bill compiler will have to exercise judgement as to the extent to which the contractor is alerted to the potential effects of the presence of water.

Risk issue

The issue of water is an interesting one as there is no provision in CESMM4 for measuring excavation below groundwater level or in running water or for the disposal of groundwater as there is in NRM2, for instance.

In such circumstances, the contractor must turn to the conditions of contract for relief if it is felt that the physical conditions encountered could not *reasonably have been foreseen by an experienced contractor* (ICE/ICC – Measurement Version, Clause 12) or merit the notification of a compensation event (Clause 61.3) under the NEC3.

Ground and excavation levels

Paragraph 5.22 applies to items of work involving excavation, boring or driving and requires that:

- Each item description shall state the Commencing Surface where this is not the Original Surface.
- Each excavation item shall state the Excavated Surface provided that this is not the Final Surface.
- Depths of excavation stated in accordance with the Work Classification shall be measured from the Commencing Surface to the Excavated Surface.

The object of these rules is to expand on Section 1: *Definitions* and ensure that the contractor is clear where such work starts and finishes. If there are intermediate stages in an excavation, the excavated surface of one stage becomes the commencing surface of another, but there is no requirement to relate these surfaces to a level. Practical phrases such as ‘1 m below original level’ or ‘top of rock’ are sufficiently clear for the purposes of this rule.

Paragraph 5.23 is incongruous under this heading and appears to be left over after the deletion of Paragraph 5.22 in CESMM3 (Form and setting of bills of quantities) which does not appear in CESMM4. The paragraph refers to the totalling of bill pages, carrying totals to a Part Summary and carrying the part summaries to the Grand Summary.

7.7.7 Grand Summary

The Grand Summary brings together all the various part summaries of the Bill of Quantities which shall be listed together with their respective monetary totals (Paragraph 5.24).

Underneath the total of the part summaries, three items shall be included:

General contingency allowance

Provided that the employer agrees, a contingency sum shall be included as a reserve fund to cover items of expenditure not provided for in the bill of quantities. There is no rule in Paragraph 5.25

governing the amount to be included, except that it shall be an item, not a percentage, and it may be expended in full or in part or not at all depending on the circumstances that arise on-site.

Adjustment item

The adjustment item is provided so that the contractor may conveniently make last-minute changes to the tender total without altering the rates and/or prices in the Bill of Quantities. Paragraphs 6.4 and 6.5 explain how the adjustment item works with respect to interim payments, retention and contract price fluctuations:

For interim payments, a *pro rata* addition or deduction* is paid/deducted in instalments, but not exceeding the total of the adjustment item, in the proportion:

Adjustment Item	Less	Retention (if any)
Total of BQ ± Adjustment Item		

Total of the priced bill of quantities

The monetary total of the part summaries, contingency allowance (if any) and adjustment item represents the contractor's tender total.

If the form of contract used is the ICC – Measurement Version or NEC3 Option B (priced contract with bill of quantities), then the tender total will be subject to admeasurement.

Should JCT 2011 SBC/Q or NEC3 Option A (priced contract with activity schedule) be used, however, the tender total will be a lump sum subject to adjustment only as prescribed in the contract.

7.8 Section 6: Completion, pricing and use of the Bill of Quantities

Changes from CESMM3

- Reference to pound sterling omitted. Now refers to *currency of the contract* (Paragraph 6.1)
- Now refers to *interim payments, interim certificates and completion of the works* rather than ICE contract references (Paragraph 6.4)
- Now refers to a *contract price fluctuations* clause rather than the UK-centric 'Baxter formula' references (Paragraph 6.5)

7.8.1 Insertion of rates and prices

Although there is no guidance on how the bill of quantities pages should be set out, as there was in CESMM3 (Paragraph 5.22: *Form and setting*), CESMM4 Paragraph 6.1 nonetheless prescribes that the *rates and prices shall be inserted in the rate column*. This follows CESMM3 albeit the general convention in the industry is to insert rates in the rate column and the prices (i.e. sums of money such as general items and method-related charges) in the extension column (£-p).

Paragraph 5.22 refers specifically to *the currency of the contract* (CESMM3 did not) which hints at the internationalisation of CESMM4. The prevailing currency will be that stated in the conditions of contract:

- NEC3 – Contract Data Part 1.
- FIDIC – Appendix to Tender.

In contracts where there is no provision for stating the currency of the contract (e.g. ICC – Measurement Version), care would be needed to make sure this was included somewhere in the contract documents (e.g. ICC – Measurement Version, Clause 72: *Special conditions*).

Attention may also have to be paid to circumstances where payment for work in progress is to be made in more than one currency.

7.8.2 Parts to be totalled

Paragraph 6.2 states that *each part of the Bill of Quantities shall be totalled and carried to the Grand Summary*. This is a (not quite) verbatim repetition of Paragraph 5.23.

This presupposes that the bill of quantities is subdivided into parts, which is optional pursuant to Paragraph 5.9, albeit Paragraph 5.2(d) suggests that the work items shall be *grouped into parts*.

Some work items could be grouped (e.g. Classes F and G or Classes I–L), but these provisions are less than clear.

7.8.3 Adjustment item

The tendering period is a time of intense activity for the contractor, especially on large projects when a team of estimators, buyers, quantity surveyors, planners, construction managers, senior managers and directors will undoubtedly be involved. Towards the end of the process, many aspects of the tender come together rapidly – alternative methods of construction are considered, the pretender programme is finalised, risk issues are assessed, cheaper quotes for materials and temporary works are received, last-minute subcontract quotations are submitted, etc.

By this time, the bill of quantities will have been priced, rates will have been grossed up (i.e. overheads and profit added to direct costs), preliminaries will have been priced, and the contractor will be close to submitting the finalised bid. Nevertheless, final adjustments will be made to the tender to take account of last-minute economies and changes of mind, and the directors will wish to reflect on the competition and how much they want to win the contract.

With this in mind, adjustments may have to be made to the priced bill of quantities, and this will involve either making changes to the rates and prices or finding a place in the BQ to make an amendment so that the priced BQ totals to the tender figure that the directors decide upon.

Anyone who has been an estimator will know how manic the ‘last knockings’ of a tender submission are, and it was with some relief that the first edition of CESMM introduced the idea of an adjustment item in the Grand Summary. This has been retained in subsequent editions.

Paragraph 6.3 provides for an Adjustment Item to be given in the Grand Summary and gives the tenderer the option of pricing a lump sum addition or deduction to the total of the priced bill of quantities against it.

This conveniently gives the contractor the chance to quickly adjust the BQ total to the tender total that has been decided on but, at the same time, creates complications with regard to post-contract matters such as payment and the valuation of variations.

If, for example, the contractor has made a last-minute deduction to the BQ total, interim payments must be reduced accordingly in order to avoid overpayment to the contractor, and vice versa. The adjustment made to the interim payment shall be a proportionate adjustment made prior to the deduction of retention. Any positive or negative balance that is left of the adjustment item, once contract completion is reached, shall be added to or deducted from monies due.

Ross and Williams (2013) give a worked example of how an adjustment item works in practice (reproduced in Table 7.7).

Table 7.7 Adjustment item.

Adjustment item at tender stage						
Ref	Item	Quant	Unit	Rate	£	p
GRAND SUMMARY						
A	Class E: Earthworks				146 973	96
B	Class F: In-situ concrete				49 334	72
C	Class G: Concrete ancillaries				9 874	21
D	Class P: Piles				98 652	98
E	Class Q: Piling ancillaries				13 788	67
F	Class U: Brickwork, blockwork and masonry				17 463	22
G	Class W: Waterproofing				6 998	44
	Bills of Quantities Total				343 086	20
	Adjustment item				12 196	20
	TENDER TOTAL				330 890	00

Adjustment of interim valuation:

<ul style="list-style-type: none"> • Paid or deducted in instalments • Adjusted in proportion to the total of the bills of quantities before the addition/deduction of the Adjustment Item • Adjusted before deducted of retention monies • Adjustments shall not exceed the total of the Adjustment Item 	Gross interim valuation			£	p	£	p
	Adjustment:					104 746	96
	£12 196.20	x		104 746	96	(3723)	(60)
	£343 086. 20					101 023	36
	Retention	3 %				3 030	70
	Certified value					97 992	66

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Paragraph 6.5 further requires that suitable adjustment shall be made in respect of the adjustment item to any payments due to the contractor in the event that a contract price fluctuations clause is applicable to the contract.

7.9 Section 7: Method-related charges

Changes from CESMM3

- Reference to ICE clauses omitted. Method-related charges are deemed to be **prices** (i.e. not rates) for the purposes of *valuing changes to the works and revisions to rates as a consequence of a change in quantity arising from admeasurement* (Paragraph 7.6)
- Reference to ICE clauses omitted. Method-related charges shall now be paid *in accordance with the contract* (Paragraph 7.7)
- Reference to ICE clause omitted. Changes in method shall not result in an increase or decrease in the amount of a method-related charge unless a change in method *has been ordered by the contract administrator*, in which case *the provisions of the contract in valuing changes shall apply* (Paragraph 7.8)

The first edition of CESMM pioneered the concept of separating quantity-related and method-related costs in a bill of quantities based on CIRIA (1977) Research Project 34. The concept has been imitated in other methods of measurement since.

Method-related charges remain an integral feature of CESMM4 which is testament to the vision of the original authors and to the logic and practicality of the idea.

7.9.1 Definitions

Paragraph 7.1 distinguishes between **time-related** and **fixed** method-related charges and defines a method-related charge as:

- *The sum for an item inserted in the Bill of Quantities by a tenderer in accordance with Paragraph 7.2*

A method-related charge can, therefore, be described as:

- A time-related charge *proportional to the length of time taken to execute the work.*
- A fixed charge *which is not a time-related charge.*

Risk issue

A time-related charge is taken to be proportional to the time taken to execute the work to which it relates and not 'the Works' (i.e. the contract).

For interim payment purposes, therefore, the contract administrator must judge the progress the contractor has made compared with the agreed programme when deciding on the proportion of the time-related charge to be paid.

For example:

Time-related charge	=	£10 000
Activity duration	=	10 weeks
Time expired	=	6 weeks
Actual progress	=	5 weeks
Interim payment	$\frac{5}{10} \times$	£10 000
		= £5 000

7.9.2 Insertion by a tenderer

Method-related charges are intended to cover items of work that the **contractor** deems necessary in order to construct and complete the Works, which is his contractual obligation. Users of NEC3 will be familiar with the distinction between 'work' and 'Works'.

All that the bill compiler has to do is provide a place in the bill of quantities for the tenderer to insert the item(s) that are desired, but he/she is not required to 'second guess' what the contractor's working methods will be. Some bill compilers, nevertheless, like to structure the Method-Related Charges section using the generic headings, others don't bother. A sample BQ page without the headings is shown in Table 7.8.

It will be noted from Table 7.8 that a preamble has been included that is neither required nor suggested by the method of measurement. A preamble is a personal preference but serves to direct the tenderer's attention to the provisions of Class A.3 and, also, to remind the estimator (at a busy period) not to forget to include the method-related charges in the BQ total.

In order to help the contractor, generic headings are provided in CESMM4 Class A: *General items* under A3: *Method-related charges*, but there is no compulsion for the contractor to use all, or indeed any, of these headings.

Table 7.8 Method-related charges.

General Items				
<p><u>Method-Related Charges</u></p> <p>Tenderers are invited to enter below such Method-Related Charges, if any, as are deemed appropriate; Method-Related Charges should be generally in accordance with Class A of the CESMM4 Work Classification but may cover items of work other than those set out in Class A</p>				

In this respect, Paragraph 7.2 explains that a tenderer is free to:

- Insert items into the BQ for method-related charges which
- Relate to the way that the contractor intends to carry out the work and
- Are intended to cover items of work that are *not to be considered* as proportional to the quantities of other items
- The cost of which are not included in the rates and prices for other items.

Tenderers are equally free *not* to insert method-related charges into the bill of quantities, and as many or as few of such items as are considered necessary may be inserted.

The words 'not to be considered' are underlined because this emphasises, along with Paragraph 7.6, that method-related charges are not subject to admeasurement and will not be changed if the quantities of related items increase or reduce. There is a caveat to this, however, as discussed in Section 7.9.6.

In the days that CESMM was directly linked to the ICE conditions, contractors could be assured that:

- Changes in quantities are not variations.
- Method-related charges are not subject to admeasurement unless a variation is instructed.
- Money priced against method-related items is a safe repository, not only for non-quantity-related costs but also for margin moved from other items in order to front-load tenders, unless there is a variation affecting the work concerned.

This would still be the case if the ICC – Measurement Version was to be used, because the ICE and ICC conditions are essentially the same; the FIDIC (Red Book) operates similarly to the ICE conditions as regards variations to the contract.

Risk issue

Now that CESMM4 is contract neutral, the method of measurement could be used with conditions of contract that are not the same as ICE, ICC or FIDIC:

- CESMM4 could be used with JCT 2011 SBC/Q which recognises changes in quantities as a variation.
- Under NEC3 ECC (Black Book) Option A, all prices are lump sums and are not remeasurable. However, if there is a change to the Works Information which has the effect of reducing Defined Cost, the prices (including method-related charges) are reduced.

7.9.3 Itemisation

Paragraph 7.3 suggests that method-related charges should follow the Work Classification order in Class A. This provides a structure for the General Items that the bill compiler may choose to provide in the bill of quantities. Alternatively, it may be left for tenderers to ‘write in’ the detail as necessary. If the Class A.3 structure is not fit for a particular purpose, tenderers can add their own items.

In any event, time-related and fixed charges should be distinguished although there is no obligation to do so. Contractors often like to split up method-related charges in this way as fixed charges such as mobilisation costs, installing cofferdams and providing haul roads represent ‘early money’ payments to help reduce capital lock-up in projects.

7.9.4 Description

Paragraph 7.4 is a ‘rule’ in that method-related items *shall be fully described so as to*:

- *define precisely the extent of the work covered.*
- *identify the resources to be used.*
- *identify the particular items of Permanent Works or Temporary Works, if any, that the method-related item relates to.*

These obligations rest firmly at the door of the tenderer (not the bill compiler) because:

- It is the tenderer who ‘writes in’ the method-related items.
- Unlike other items in the Work Classification, there is nothing on the drawings or in the specification that amplifies the BQ description.
- The clearer the item description, the easier it will be for the contract administrator to value work in progress and variations to the contract which is obviously crucial to how much the contractor will be paid.

7.9.5 Contractor not bound to adopt method

It is frequently the case that contractors change their minds as to how to carry out the work on-site once the contract has been awarded. The involvement of construction management staff will be influential in this, and it is no reflection on the estimating team that a different method is adopted to that which the tender is based on.

In common with all other items in a priced bill of quantities, the moneyed items are purely ‘allowances’ or budgets, and Paragraph 7.5 acknowledges the contractor’s right to spend this money in any way deemed appropriate.

Consequently, a method-related charge for a cofferdam does not preclude the contractor being paid this sum if he decides to ‘batter’ the excavation nor will the contractor be refused payment if he chooses ready-mixed concrete instead of using the site batching plant priced in the method-related charge in the bill of quantities.

The only thing that will change in each of these instances is the cash flow for each method-related charge. In the first case, payment could be proportional to other excavation and filling works, and in the second case, it could be proportional to the quantity of concrete placed but subject to the provisions of CESMM4, Paragraph 7.8 (see Section 7.9.8).

In both cases, the full amount of the method-related charge will be paid on completion, barring variations.

7.9.6 Charges not to be measured

As discussed in Section 7.9.2, CESMM4 Paragraph 7.6 stipulates that method-related charges *shall not be subject to admeasurement*.

In Paragraph 7.1, a Method-Related Charge is defined as *a sum for an item inserted in the Bill of Quantities* and therefore is not a rate or a price by definition. Consequently, if a contractor prices a method-related charge for a cofferdam, he will be paid the same sum of money irrespective of whether more or less or no sheet piling at all is actually needed.

Risk issue

The point with Method-Related Charges is that the contractor carries the risk attached to his chosen method of working.

If he finds a better, quicker, cheaper method, or if he is lucky with the weather or ground conditions, then he benefits from the 'upside' risk. The 'downside' is that if things go 'pear-shaped', the contractor foots the bill.

Notwithstanding this, Paragraph 7.6 explains that method-related charges *shall be deemed to be prices*, and therefore can be adjusted, in certain circumstances:

- For the purpose of *valuing changes to the works*.
- For making appropriate *revisions to rates* where the process of *admeasurement* results in a change of quantity of items that are not themselves method-related charges.

Therefore:

- If, through the process of admeasurement, rates and prices in the bill of quantities are rendered unreasonable or inapplicable and should be reviewed, this review would include associated method-related charges.
- If the characteristics of measured work items change significantly, or if the conditions under which such work is to be carried out are not as described in the contract, method-related charges could be changed accordingly.
- If the risk associated with any work changes, then the accompanying method-related charges would be reassessed.
- If a variation changes the work envisaged, method-related charges could be reviewed.
- If work is omitted from the contract, any associated method-related charge would not be payable.

Risk issue

It should be noted that the term 'admeasurement' is peculiar to the ICC – Measurement Version but that other standard contracts use words and phrases that essentially mean the same thing.

Therefore, in a measure and value contract, the admeasurement process will take place, if not in name, in order to identify **differences** in the estimated and final quantities of work for the purpose of arriving at a fair valuation of work done.

If this process indicates that the BQ rates should be revisited in the circumstances, then method-related charges will be part of the review in order that a fair valuation is determined.

7.9.7 Payment

CESMM4, Paragraph 7.7, requires that method-related charges *shall be certified and paid in accordance with the contract*. This is a change in the wording of CESMM3 which, of course, makes reference to the ICE Conditions of Contract.

The significance of the new wording relates to:

- Who prepares the valuation of work in progress – under some contracts, it is the contractor, and in others, it is the contract administrator or project manager (NEC3 ECC).
- Whether or not the contractor is paid for incomplete items of work (he is not under NEC3 ECC Option A).
- Whether retention is deducted from the valuation or not (this is a secondary option under NEC3 ECC).
- The contractual timing requirements for the issue of certificates and payments.

In order to highlight that the certification and payment régimes vary from contract to contract, a statement to the effect that method-related charges **shall be certified and paid in accordance with the contract** *shall appear in the Preamble to the Bill of Quantities*.

7.9.8 Payment when method not adopted

Under the provisions of Paragraph 7.5, the contractor is not bound to adopt the method of working that he has described in the item that he has priced as a method-related charge in the bill of quantities. The contractor is, nonetheless, entitled to be paid for a method-related charge in such circumstances with the proviso that the work in question has been satisfactorily carried out (Paragraph 7.8).

The issue raised in Paragraph 7.8 is one of payment for method-related charges where the contractor does not adopt the method of working stated in the item description. Two methods of payment are proposed:

1. The contract administrator and the contractor agree the amount(s), timing and trigger points for a number of instalment payments. For example:
 - a) Installation/mobilisation (one-off payment), maintenance (monthly) and removal/making good (one-off payment).
 - b) In proportion (*pro rata*) to the completed associated permanent works.
2. Failing such agreement, the method-related charge *shall be treated as if it were an addition to the Adjustment Item* and shall be paid to the contractor by way of payments in interim certificates.

Risk issue

The operation of Paragraph 7.8 should be carefully considered in relation to the prevailing conditions of contract in order to avoid possible conflict.

For instance, payment under NEC3 ECC Option B (priced contract with bill of quantities), Clause 11.2.28, is assessed by the project manager on the basis of:

- The quantity of work completed.
- A proportion of each lump sum (which could include method-related charges).

However:

- The lump sum is apportioned on the basis of the completed amount of work covered by the lump sum and NOT the completed amount of associated [permanent] works.
- The project manager is obliged to *consider* any payment application by the contractor but is not obliged to take any notice of it or to discuss it with the contractor (Clause 50.4).

If Option B is used, consideration should be given to amending CESMM4, Paragraph 7.8, so as to avoid possible conflict with the conditions of contract.

This could be done by including a statement in Contract Data Part 1, in the space provided, to the effect that the method of measurement has been amended in the manner considered appropriate in the circumstances.

Paragraph 7.8 concludes by emphasising that the contractor is entitled to be paid the full amount of the method-related charge, despite not adopting the stated method of working, unless the change in method has been instructed by the contract administrator. In this event, a variation/change order/compensation event would arise, and this would be valued according to the provisions of the conditions of contract relating thereto.

7.10 Work classification

The Work Classification is the heart of CESMM4 and comprises 26 classes of work, listed alphabetically, including preliminaries (Class A).

Application of the Work Classification has already been discussed in Section 7.5, but there are two additional issues that deserve attention.

7.10.1 'Included' and 'excluded'

Each class is provided with a title, beneath which is a heading in bold text of inclusions and exclusions, followed by the detailed work classification, in three divisions, and the various measurement, definition and other rules.

The heading is important because it states the type of work that is included in each class and also what is not included in each class. Consequently, if a type of work is not included in the heading to the class, then, by definition, it is excluded either:

- Because it is included in another class or
- It is not provided for in the method of measurement.

Take ground freezing – a geotechnical process for altering the properties of soil – as an example.

The technique basically entails the circulation of a cryogenic fluid, such as brine or liquid nitrogen, through a system of pipes drilled into the ground from the surface. Pore water is thereby converted into ice, and pumping continues until the particular design thickness is reached. Once this has been achieved, the freeze plant is operated at a reduced rate in order to maintain the ground in its 'frozen' state.

Geotechnical processes carried out from the ground surface are specifically **excluded** from Class T: *Tunnelling* and specifically **included** in Class C: *Geotechnical and other specialist processes* as stated in the Class T heading. Class C includes *geotechnical processes for altering the properties of soils and rocks* because this is expressly stated in the Class C heading.

Looking at Class C, however, ground freezing is not specifically listed in the Work Classification, and the only drilling items provided are for grouting work (freezing is not grouting).

CESMM4, therefore, does not provide a work classification for ground freezing, and the bill compiler is left with two choices:

1. Adapt the method of measurement in a suitable way, and include a preamble, so that measured items for ground freezing can be included in the bill of quantities.
2. Include a provisional sum for defined work in Class A: *General items*.

7.10.2 Additional description rules

Work is classified in CESMM4 according to the Work Classification, and bill of quantities items are developed from the descriptive features provided in the First, Second and Third Divisions. This is done in conjunction with the measurement rules and definition rules, and contractors are able to understand what is included in the various items by reference to the coverage rules.

The Work Classification is very brief, however, and the resulting item descriptions may not always convey the full extent of the work represented in the measured item in the bill of quantities. This is the role of the Additional Description Rules.

The importance of Additional Description Rules cannot be overemphasised as they ‘flesh out’ the otherwise limited descriptive information provided in the first three divisions of the method of measurement. Consequently, a great deal of the bill compiler’s time is occupied with incorporating additional description into the various BQ items. Additional coding may also be required.

The provision of additional description is, however, not limited to the additional description rules provided in each class. It is also influenced by the bill compiler’s judgement in interpreting the requirements of CESMM4, Paragraph 5.11, which states that *further itemisation and description may be provided* should circumstances arise that require *special methods of construction or considerations of cost*.

Risk issue

Failure to observe the Additional Description Rules is equivalent to failing to describe an item correctly and, as such, might constitute a misrepresentation of the work to be priced in the contractor’s tender.

7.10.3 Non-standard work

Barnes (1977) raises the issue of *non-standard work* with reference to Class Q: *Piling ancillaries* in the context of pile extraction that is not included in the Work Classification.

By this authority, it seems that the bill compiler has some licence to expand the ambit of CESMM4 not envisaged by Paragraph 5.4.

Whilst Paragraph 5.4 gives tacit approval to amending CESMM4, this would necessitate a statement being given in the Preamble, whilst the discretion implied by Barnes (1977) would appear to suggest that a measured item marked *non-standard work* would suffice.

7.11 Class A: General items

Changes from CESMM3

- Insurance of the Works and third-party insurance no longer listed in the Second Division
- A 1 2 0 *insurances* – no longer any subdivision for different classes of insurance
- C1 revised – there are no longer any *deemed to be included* provisions
- C1 must be defined in the schedule of specific clauses under Section 5: Paragraph 5.6
- A 1 3 0 *parent company guarantee* is new (M2 refers)
- *Specified requirements* – *contract administrators* replace *engineer’s staff*; no longer any reference to *staff*
- A 4 2 0 – Provisional Sums are now for *defined work* (M7, D2, C2 and A5 refer) as well as Daywork

Class A is the ‘preliminaries’ section of CESMM4.

The unit of measurement in Class A is discretionary, but Measurement Rule M1 suggests that it *may be the sum*. In the case of a *parent company guarantee* (A 1 3 0), Rule M2 states that *an item may be given*.

There are six categories in the First Division of Class A:

1. Contractual requirements	
2. Specified requirements	
3. Method-related charges	See also Section 7.9
4. Provisional sums	
5. Nominated subcontracts which include work on the site	} See Section 7.7.6
6. Nominated subcontracts which do not include work on the site	

7.11.1 Contractual requirements

CESMM4 has rationalised the Second Division descriptive features of *contractual requirements* and now includes reference to *parent company guarantee* as well as a *performance bond*.

Measurement Rule M2 confirms that a parent company guarantee is an optional provision where a tenderer may be part of a larger company or group.

Risk issue

The choice between a parent company guarantee and a performance bond, provided by a bank or insurance company, requires careful consideration as each provides a different remedy.

A parent company guarantee should ensure that the contract is satisfactorily completed, subject to the continuing solvency of the parent company, whereas a performance bond simply provides a guarantee of a payment, up to a defined limit, in the event of the contractor’s default.

The Second Division now only refers to *insurances*, and there is no longer any subdivision into classes of insurance such as works insurance, third-party insurance (see Table 7.9). This is probably sensible because different forms of contract use different phraseology when referring to the types of insurance cover and indemnity limits required.

Coverage Rule C1, which relates to insurances, contains no item coverage information, but the meaning of this rule must be defined in the ‘schedule of specific clauses’ which is now required under Section 5: Paragraph 5.6.

Table 7.9 Insurances.

General Items				
<u>Contractual requirements</u>				
A	Insurances		sum	
B	Parent company guarantee		sum	

7.11.2 Specified requirements

Specified requirements are measured in accordance with Rule M1, but where the value of any item is *to be ascertained and determined by admeasurement*, a quantity shall be given for each item in accordance with Rule M3.

Admeasurement is a process for measuring changes during the works, and therefore, bill compilers need to be alert to any specified requirements that might be varied during the contract so that a quantity can be included.

On any contract of substance, facilities are needed for the employer's representatives on-site. Formerly, CESMM provided for facilities for the *engineer's staff*, but the fourth edition, being contract neutral, has different wording. The term '*contract administrators*' is now employed, in the plural, as a collective term for the employer's team. The word 'staff' is no longer used, presumably because not all of the employer's representatives are necessarily directly employed.

Class A 2: *Specified requirements* are defined in Rule D1 as *work other than the permanent works* that is *expressly stated in the contract*. As there are no Class A coverage rules, it must be taken that the word *work* implies that *specified requirements* shall be fully functioning, and this is to some extent dealt with in Rule A2 which refers to *their continuing operation or maintenance*:

- Rule A2 requires that item descriptions for *specified requirements* shall *distinguish between the establishment and removal of services or facilities and their continuing operation or maintenance*.
- Additional Description Rule A1 states that *specified requirements* needed *after the date for completion* shall be so described in the relevant items.

Risk issue

There is no definition of *completion* in CESMM4, and consequently, any specified requirement that is to be maintained after completion must be correctly referenced to the intended meaning of 'completion'.

'Completion' has several meanings depending upon the conditions of contract used, all of which use different terminologies.

Standard contracts tend to view completion in two stages:

- An 'initial' completion and then, when defects have been corrected:
- A 'final' completion.

The satisfactory conclusion of a defined period after 'initial' completion, usually 6 or 12 months, brings the contract to an end:

Contract	'Initial' completion	'Final' completion
ICE	Substantial completion	Defects correction period
FIDIC	Completion (subject to passing the tests on completion)	Defects notification period
ECC	Completion date	Defects correction period
JCT	Practical completion	Rectification period

Item descriptions should be drafted carefully so that the precise meaning of 'completion' is conveyed and tenderers may price the relevant item accurately.

Specified requirements include accommodation and the provision by the contractor of services and facilities for the contract administrators. In Table 7.10, it can be seen that additional description has been provided for ‘accommodation’ pursuant to Rules A1 and A2.

Table 7.10 Specified requirements.

<u>Specified requirements</u>				
Accommodation for the contract administrators				
A	Offices; Establishment		sum	
B	Offices; Maintenance		sum	
C	Offices; Maintenance during Defects Correction Period		sum	
D	Offices; Removal		sum	
Services for the contract administrators				
E	Transport vehicles; 2 nr 4 x 4 vehicles as per Specification		sum	

7.11.3 Specified requirements: Temporary works

Specified requirements include testing and temporary works, such as traffic diversions, cofferdams and dewatering.

The temporary works categorised under Class A 2 7 * differ from those listed under Class A 3 5 * and A 3 6 * in that they are specified as being required and are not at the contractor’s discretion. As such, these items will be listed in the bill of quantities, along with any required additional description, whereas the contractor’s method-related charges are to be inserted by the tenderer.

Additional description for *Specified requirements – Temporary works* – is required under Rule A1 (post-completion requirements) and Rule A2 (establishment, maintenance and removal).

Where *specified requirements* are to be subject to *admeasurement*, a quantity shall be given for each item in accordance with Rule M3. This also provides scope for variations during the works, and any item likely to be subject to change will require a quantity against the item. There might, for instance, be a specified requirement for dewatering to a specific zone of the site, or the specification may contain particular provisions regarding compressed air working pressures, each of which might need to be varied.

This is illustrated in Table 7.11, which also shows how locational information, whilst not specifically required for A 2 7 * items, is provided pursuant to Paragraph 5.14.

7.11.4 Method-related charges

Pursuant to Measurement Rule M4, *Method-related charges (if any) shall be inserted by the tenderer*. This topic has been discussed, at length, in Section 7.9 of this chapter.

Table 7.11 Specified requirements – admeasurement.

Temporary Works					
A	Traffic diversions; Tarrant Road; Establishment		sum		
B	Traffic diversions; Maintenance		sum		
C	Traffic diversions; Removal		sum		
D	Bridges; Temporary; 2-way traffic: River Winchet; Establishment		sum		
E	Bridges; Temporary; 2-way traffic: River Winchet; Maintenance		sum		
F	Bridges; Temporary; 2-way traffic: River Winchet; Removal		sum		
G	De-watering; Wellpoint; Chainage 1+200 to 1+600; Establishment	10400	m2		
H	De-watering; Wellpoint; Chainage 1+200 to 1+600; Maintenance	10400	m2		
J	De-watering; Wellpoint; Chainage 1+200 to 1+600; Removal	10400	m2		

Additional description is required under Rule A4 for *Method-related charges* in order to distinguish between fixed and time-related charges.

There should be no reason why tenderers would not observe this requirement because it is beneficial to contractors for all sorts of post-contract reasons. However, where the rule has not been respected, this could be picked up in the pre-contract checking of tenders and insisted upon by the employer prior to entering into a contract.

There is no guarantee, however, that any method-related charges, or other rates and/or prices for that matter, will not be priced with ‘commercial opportunity’ in mind. Contractors are alert to opportunities to enhance the value of variations/compensation events and ever mindful of the need to reduce negative cash flow on contracts!

7.12 Class B: Ground investigation

Changes from CESMM3

None

Ground investigation work is usually carried out in advance of a contract so that borehole and trial pit logs may be supplied to tenderers.

In this respect, Class B: *Ground investigation* may be used as part of the procurement process for a 'stand-alone' ground investigation contract, perhaps in conjunction with a suitable form of contract such as the ICC Ground Investigation Version.

Ground investigation items are deemed to include the preparation and submission of records and results in accordance with Coverage Rule C1, but the preparation of analysis reports is regarded as a matter for a separate item under Class B8: *Professional services*. Alternatively, analysis of ground investigation records and results may be undertaken under a separate contract for professional services such as the NEC3 Professional Services Contract.

Where ground investigation is required during a construction contract, it is normal to ask the contractor to excavate trial pits and trenches in order to verify ground conditions or to locate underground services.

Trial pits and trenches warrant two measured items:

1. An enumerated (nr) item stating the maximum depth in depth bands (B 1 * *) with additional description giving the minimum plan area at the bottom of the pit or trench and, for locating services, the maximum length of the trench (Rule A1).
2. An item, in linear metres, measuring the depth of pits and trenches stating the minimum plan area at the bottom of the pit or trench or, in the case of work to locate services, the maximum length of the trench.

The BQ items for 10 nr trenches to locate existing services are shown in Table 7.12.

Table 7.12 Ground investigation.

Ground Investigation					
<u>Trial pits and trenches</u>					
Number in material other than rock					
A	Maximum depth: 2-3 m; maximum length of trench 5 m	10	nr		
Depth in material other than rock					
B	To locate services; maximum length of trench 5 m	25	m		
Depth backfilled;					
C	Excavated material; maximum length of trench 5 m	25	m		

The alternative to items measured in the contract bills is for the contract administrator to instruct the work to be carried out on a Daywork basis (ICC/ICE contracts) or to value it as a compensation event using the Shorter Schedule of Cost Components (ECC contracts).

7.13 Class C: Geotechnical and other specialist processes

Changes from CESMM3

- Grout holes and grout materials and injection combined (First Division)
- Materials now C 4 5 *
- **NB:**
There is a mistake in the Second Division of C 4: *grout holes, materials and injections*. C 4 5 * should be separated from C 4 1–4 with a solid line. The Third Division list of grouting materials (1–6) belongs to C 4 5 which requires descriptive features in order to complete the itemisation of C 4 5 * materials (CESMM3 refers)
- BS 4449 deleted from C 5 5 * and C 5 6 * (diaphragm walls)
- D3 – reference to BS 4449 deleted
- *Ground anchorages* is now *ground reinforcement* (D4 and A8 refer)
- C 8 * * *Vibroflotation* added

Items for geotechnical work now include ground reinforcement and vibroflotation as well as ground anchors and diaphragm walls, etc.

For all work in this Class, the Commencing Surface shall be stated where this is not the Original Surface (Section 5, Paragraph 5.22), and this shall be used for the admeasurement of completed work (Rule M1). All items in Class C are deemed to include disposal of excavated material and the removal of dead services (Rule C1).

7.13.1 Ground anchors

The measurement of ground/rock anchors is a little involved as there is a multiplicity of items to be measured for this work in Class C:

1. Drilling for grout holes and injection pipes (C 1–3 * *).
 2. Items that define the extent of the work involved:
 - a) Number of holes (C 4 1 0)*.
 - b) Number of stages (C 4 2 0).
 - c) Water pressure tests (C 4 3–4 0).
 3. The supply of grout materials (C 4 5 *).
 4. Injection of the grout holes with a choice of grout types (C 4 6 *).
 5. Supply, installation and stressing of tendons, testing and constructing anchor heads, etc. (C 6 * *).
1. Drilling for grouting is described as either through *rock or artificial hard material*, or through material other than rock or artificial hard material (i.e. normal ground), and measured in linear metres. Where both ground conditions are present, a quantity is presumably required for each. The drilling inclination is given in the Second Division and the depth of drilling in the Third Division within bands (not exceeding 5 m, 5–10 m, etc.). The diameter of holes is to be given in item descriptions (Rule A1).
 2. Additional enumerated items are given for the number of holes, for the number of drilling stages and for carrying out single or double water pressure tests. To some extent, these items reflect the costs of re-mobilising the drilling rig from position to position and moving it around the site.
 3. The supply of grouting materials is measured by mass (t), but there is no rule that determines how the quantities shall be calculated for the bill of quantities (e.g. a nominal

mass per m³) or how they shall be verified for admeasurement (e.g. supply of delivery tickets, goods received sheet).

4. Injection is measured by the number required (C 4 6 *), with a separate item for the grout material. The dry materials are measured under C 4 5 in conjunction with a list of cement, fillers and chemicals in the Third Division (features 2–5). The enumerated items represent the cost of preparation, mixing and delivery of grout to the injection point.
5. The number of ground anchorages (nr), and the total length installed (m), either in material other than rock or artificial hard material or in material which includes rock or artificial hard material, are measured in C 6 * *. The measured items shall include details of the location and composition of the anchorages as well as working load and other testing details.

A practical example of the measurement of ground anchors is provided in Chapter 15.

7.13.2 Diaphragm walls

Diaphragm walls are measured in Class C 5 * * and are defined as *walls constructed using bentonite slurry or other support fluids* (Rule D2). They are categorised in the Second Division according to:

- Excavation.
- Concrete.
- Reinforcement.
- Joints and guide walls.

<http://www.youtube.com/watch?v=aMyLEpEM9Hg>

Excavation is measured in *rock, artificial hard material or material other than rock or artificial hard material*, in m³. Depth measurement is taken from the adopted Commencing Surface (Rule M1), and excavation items are *deemed to include preparation and upholding the sides of excavation* (Rule C2). The nature of the material to be excavated (e.g. mass concrete) shall be stated for excavation items described as artificial hard material (Rule A5 refers).

There is no item for preparing the surfaces of diaphragm walls to receive other works (e.g. brickwork, copings, capping beams) as this is deemed included in concrete items (Rule C3 applies).

Concrete is measured in m³ from the required cut-off levels with volumes calculated in accordance with Measurement Rules M1 and M2 of Class F and, of course, with CESMM4, Paragraph 5.19 (i.e. net dimensions taken from the drawings). Item descriptions for excavation and concrete shall state the wall thickness (Rule A4).

Diaphragm walls are constructed by excavating a series of alternate rectangular panels, filled with bentonite and then rebar and concrete, with stop ends forming the key for the subsequent ‘infill’ panels. This forms a continuous wall which may include water bars cast into place using the stop end formwork.

The on-plan configuration of diaphragm walls can be complex, which increases the complexity of work and adds cost. However, there is no requirement to identify this in item descriptions.

Reinforced concrete guide walls, typically 1–1.5m deep, are constructed either side of diaphragm walls in order to provide a template for wall excavation and panel layout, to provide earthwork support to the top of the trench and to perform a number of ancillary functions, such as restraint for end-stops, hanging rebar cages, supporting ‘tremie’ pipes and so on. In practice, pre-trenching is often carried out to remove shallow obstructions and facilitate construction of the guide walls. This is not recognised in the method of measurement and would come under the heading of ‘contractor method’.

Guide walls are measured in linear metres to each side of the diaphragm wall (Rule M12). There is no coverage rule for the measurement of guide walls.

Figure 7.5 and Table 7.13 show sample take-off and bill items for a diaphragm wall to a 30m×20m basement 21 m deep with rock head at 3 m above the Final Surface.

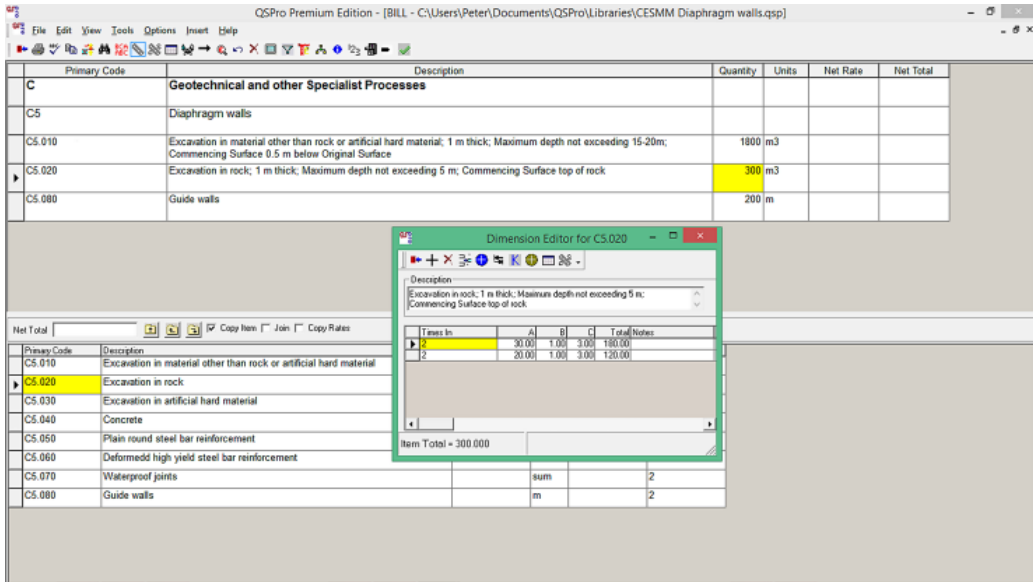


Figure 7.5 Diaphragm wall.

Table 7.13 Diaphragm wall.

Geotechnical and other Specialist Processes					
<u>Diaphragm walls</u>					
A	Excavation in material other than rock or artificial hard material; 1 m thick; Maximum depth not exceeding 15-20m; Commencing Surface 0.5 m below Original Surface	1800	m3		
B	Excavation in rock; 1 m thick; Maximum depth not exceeding 5 m; Commencing Surface top of rock	300	m3		
C	Guide walls	200	m		

7.13.3 Vibroflotation

Vibroflotation is a new First Division descriptive feature in CESMM4 with, disappointingly, little to distinguish it. This geotechnical process is defined as follows:

*Compaction of granular soils by depth vibrators is known as Vibro Compaction. The method is also known as Vibroflotation.*³

The method involves the introduction of a ‘vibroprobe’ into the ground on a predetermined grid, and a combination of vibration, water and air compacts the subsoil. A certain amount of regrading of the commencing surface is required as part of the process.

The number of probes is enumerated (nr) in the Second Division, and the depths are measured according to wide bandings in the Third Division (e.g. not exceeding 5 m, 5–10 m, 10–20 m, etc.). There is no requirement to state a particular depth within the bands, and there are no rules of any description, other than the general rules that apply to the whole of Class C.

Presumably, any performance criteria or testing requirements will be provided in the specification or on the drawings although nothing is required to be stated in item descriptions, an example of which can be seen in Table 7.14.

Table 7.14 Vibroflotation.

Geotechnical and other Specialist Processes					
<u>Vibro flotation</u>					
A	Number of probes	190	nr		
B	Depth not exceeding 10-20m	2850	m		

7.14 Class D: Demolition and site clearance

Changes from CESMM3

- General site clearance is now site clearance
- General clearance and invasive plant species added to the Second Division (D2, C3 and A3 refer)
- Trees – girths revised (D 2 * 0)
- Stumps – diameters revised (D 3 * 0)

7.14.1 Site clearance

For site clearance, there are two potential measured items in Class D:

- D 1 1 0 – General clearance.
- D 1 2 0 – Invasive plant species.

The first is measured in hectares (ha) and the second in m². In Additional Description Rule A2, the area for general clearance must be identified if this is not the total area of the site. If nothing is stated in the item description, then the area of removal of invasive plant species will effectively be ‘extra over’ general clearance.

General site clearance includes everything *expressly required to be cleared* except for those objects *for which separate items are given* in the bill of quantities as required by Class D (Definition Rule D1 refers).

This would appear to indicate, therefore, that somewhere in the tender documents there is a drawing or schedule that particularises everything that is not included in the bill of quantities.

Thus, trees of less than 500 mm girth, which are not measured individually, must be *expressly* detailed in order for removal to be deemed included in the general site clearance item.

CESMM4 includes a new category of site clearance – *invasive plant species*. Definition Rule D2 states that such species are those *whose control is governed by legislation* and requires treatment *by herbicidal or chemical process*.⁴ Japanese knotweed, giant hogweed and Himalayan balsam are well-known examples in the United Kingdom.

There are several ways to deal with such plants, and the bill compiler should take advice as to the most appropriate control measure in each case as the method of treatment must be stated in the item description as well as the type of vegetation (Rule A3). The removal of invasive plant species by digging can require extensive excavation – 500 mm or more for some species and up to 4 m for others – and disposal to a licensed tip by a licensed carrier.

Disposal of material arising from site clearance is deemed included in measured items by virtue of Coverage Rule C1, but Rule C3 also emphasises that items *shall include for the disposal of any vegetable matter remaining after treatment* where herbicidal or other treatment has been applied prior to removal. Rule C3 is a coverage rule, and thus, no additional description is required.

Risk issue

An item for the site clearance of invasive plant species should ring alarm bells for contractors because the additional description and item coverage rules could infer extensive excavation and costly disposal to a seemingly innocuous item.

7.14.2 Trees and stumps

Trees less than 500 mm girth are not measured, but those that are larger than this are enumerated stating the girth as 500 mm to 2 m and exceeding 2 m measured 1 m above ground level (Rule D3). Items shall include the removal of stumps if required (Rule C4). Tree stumps are measured by diameter (not girth) of less than or exceeding 1 m.

In both cases, holes remaining after removal that require backfilling warrant a description of the nature of the backfill in the measured item (Rule A4).

7.14.3 Buildings and other structures

The demolition and removal of buildings and other structures are measured by the *sum*.

The identity of buildings or other structures shall be given in item descriptions (Rule A5), and the Second Division list of descriptive features provided implies that a predominant material shall be stated or, alternatively, that a suitable statement will clarify that there is no predominant material present. The volume shall be stated, according to the Third Division categories, which Rule D4 deems shall be *the approximate volume occupied*.

The phrase *volume occupied* is not defined but, presumably, means the volume occupied by the building or structure which, again presumably, is the volume given by the product of its external dimensions.

Definition Rule D4 specifies that the clearance of buildings and other structures are classified in such a way as to exclude *any volume* below the Original Surface, that is, *the surface of the ground before any work has been carried out* (CESMM4, Paragraph 1.8). This, presumably, includes foundations, basements and the like.

Therefore, the removal of a ground floor slab above existing ground level would be included in the demolition item, and a similar object at or below ground level would be measured as removal of *artificial hard material* in Class E. However, a ground floor slab that is partially above and partially below the existing ground would not fall clearly into either category and would require a decision by the bill compiler as to where in the bill of quantities to include this work.

Underground tanks are not categorised but, presumably, come under the heading of *other structures* of stated material (e.g. metal) and volume range as per D 5 4 *.

7.14.4 Pipelines

The Class D heading specifically excludes *articles, objects, obstructions and materials at or below the Original Surface*, and therefore, items for the removal of pipelines must only include those above the Original Surface.

This is to some extent confirmed in Coverage Rule C5, which deems that the demolition and removal of supports are included in the measured items. Pipelines within buildings are only measured where the nominal bore exceeds 300 mm (Rule M1 refers).

7.15 Class E: Earthworks

Changes from CESMM3

- Introduction of *controlled and hazardous material* in the Second Division of excavation items at E * 6 * and E * 7 * (D4 and A7 refer)
- Also in *Excavation ancillaries* at E 5 * 5 (A11 refers)
- *High energy impact compaction of general fill* has been introduced under E6; the Second Division numbering appears wrong and should be 5 not 1 in order to create a discrete item code (M22 and A17 refer)
- In Measurement Rule M7 and Additional Description Rule A2, reference to Paragraph 5.20 should read 5.21 (Work affected by water)

7.15.1 Excavation

Barnes (1977) explains that the principle behind Class E is that excavation items should cover:

- One type of excavation (dredging, cuttings, foundations, general).
- In one type of material (topsoil, rock, material other than topsoil, rock or artificial hard material, rock and so on).

NB: The work classification, and the rules of Class E, should be read in conjunction with Section 1: *Definitions* and with Paragraph 5.22.

Earthwork depths are measured from the Commencing Surface, which shall be stated in item descriptions where this is not the Original Surface (Rule A4), but Rule A4 also provides that the Excavated Surface shall be identified in item descriptions where this is not the Final Surface.

The bill compiler needs to be aware of any circumstances in the contract where excavation is *expressly required* to be carried out in stages, as an item for each stage shall be given according to Measurement Rule M5. The phrase *expressly required* could refer to a clause in the specification, to a requirement on a drawing or to a specific preamble where a particular sequence of work is required.

Clarity is of crucial importance in the item descriptions for earthworks, and the contractor needs to fully understand how the work has been measured. Paragraph 5.22 is crystal clear that:

- Where excavation begins below the Original Surface, the Commencing Surface shall be stated:
 - This could be an Excavated Surface or
 - The Final Surface.

Therefore:

- Earthworks that follow topsoil removal commence from the underside of the topsoil which is the Excavated Surface of the topsoil item.
- Excavation below the Final Surface is, *ipso facto*, not an excavation item under E 1–4 and would be measured as an earthworks ancillary (E 5 6 0).

This logic is illustrated in Figure 7.6 in relation to the relevant bill of quantities items.

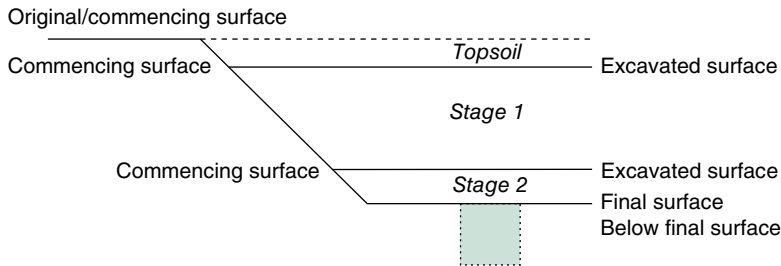


Figure 7.6 Excavation in stages.

Table 7.15 (which should be read in conjunction with Figure 7.6) shows the relevant bill of quantities items for earthworks carried out in stages compared to the items that would appear if work were not required to be done in stages.

Table 7.15 Excavation in stages/not in stages.

Excavation in stages		Excavation not in stages	
Earthworks		Earthworks	
<u>Excavation for cuttings</u>		<u>Excavation for cuttings</u>	
Topsoil		Topsoil	
A generally	m ³	A generally	m ³
Material other than topsoil, rock or artificial hard material		Material other than topsoil, rock or artificial hard material; Commencing Surface underside of topsoil	
B Commencing surface underside of topsoil; Excavated Surface 300 mm above formation	m ³	B generally	m ³
C Commencing Surface 300 mm above formation	m ³		
<u>Excavation ancillaries</u>		<u>Excavation ancillaries</u>	
Excavation of material below the Final Surface and replacement acceptable material		Excavation of material below the Final Surface and replacement with acceptable material	
D generally	m ³	C generally	m ³

In common with other classes of CESMM4, the Commencing Surface adopted for preparation of the bill of quantities shall also be used for admeasurement of the completed work.

Depth is classified in bands according to the Third Division descriptive features, but this classification only applies to foundations and general excavation and not to dredging and cuttings.

For foundations and general excavation, the depth bandings refer to the total depth of the excavation and not to the different materials within the excavation (e.g. topsoil, material other than topsoil, rock or artificial hard material, etc.). Common good practice, however, is to alert

tenderers to the presence of rock within a specific excavation, despite there being a measured item for rock, and to describe the excavations accordingly.

Table 7.16 illustrates that a general excavation, maximum depth 2–5 m, requires the removal of topsoil (normally at the surface) and that rock is measured to a maximum depth of 2 m from the point where the maximum depth of the ‘normal’ dig finishes.

Table 7.16 Excavation of rock.

Earthworks				
<u>General excavation</u>				
Topsoil				
A	maximum depth: 2-5m		m ³	
Material other than topsoil, rock or artificial hard material				
B	maximum depth: 2-5m; Commencing Surface underside of topsoil; Excavated surface top of rock		m ³	
Rock				
C	maximum depth: 1-2m; Commencing surface top of rock		m ³	

Quite frequently, in practice, there will be an interface between different classifications of excavation. There may, for instance, be a general excavation, or a cutting for a road, where there is also a structure, such as a bridge, gantry foundation or retaining wall which has a foundation to be excavated. The bill compiler needs to make a decision on how to measure the work so that tenderers may be clearly informed as to what to price.

This situation is illustrated in Figure 7.7, where it can be seen that the distinction is made between bulk excavation and excavation for foundations by using:

- a) A ‘payment line’ on the relevant drawing, which could then be referenced in the item description.
- b) The top of the second-stage excavation (i.e. the layer of earth specified to be left in place as protection for the formation) which could be used as a Commencing Surface for the foundation excavation item.

In Table 7.17, suggested method of billing is shown for excavation items relating to the crib retaining wall shown in Figure 7.7. This is to be constructed within a general excavation, and so a demarcation is needed between the bulk excavation and that for the foundation to the wall. In passing, it will be noted that Item A contains locational information in accordance with Additional Description Rule A3.

The excavation of rock and artificial hard material is provided for in the Second Division of Class E but there are no particular rules dealing with rock and artificial hard material in Class E, except for Measurement Rule M8; this limits the measurement of isolated volumes of each material which must be at least 1 m³ or a minimum of 0.25 m³, where the width of the excavation is less than 2 m.

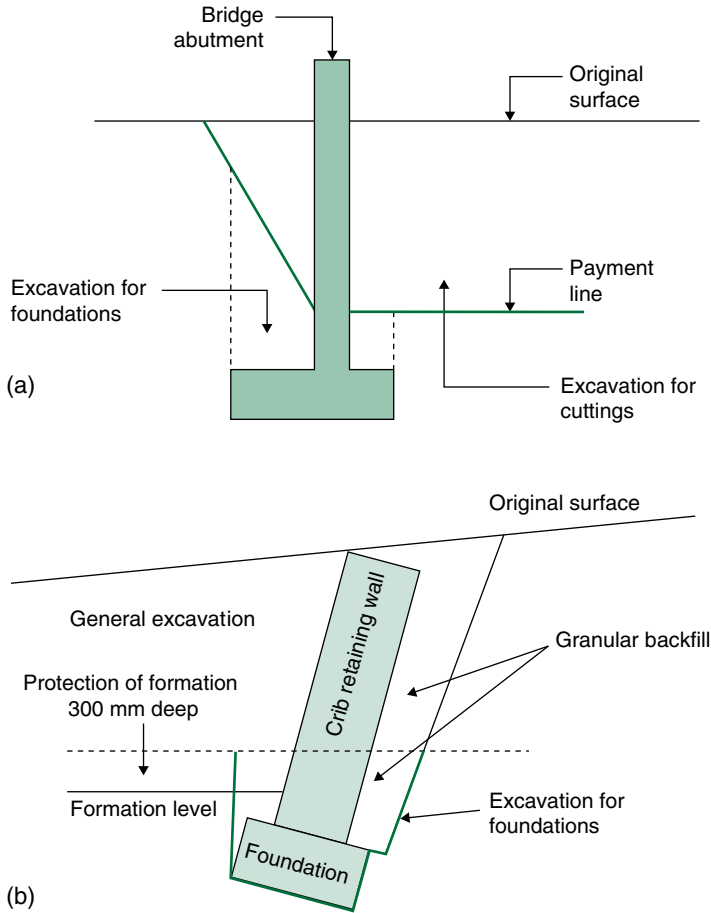


Figure 7.7 Demarcation between types of excavation. (a) Demarcation – payment line. (b) Demarcation – earthwork stages.

Artificial hard material must be described (*stated*) in item descriptions and separately billed as *exposed at the Commencing Surface* or *not exposed at the Commencing Surface*. Rock is not defined in CESMM4. In both cases, the Third Division depth categories are applicable only to general excavation and excavation for foundations.

Risk issue

The *Commencing Surface* is not necessarily the *Original Surface* and could equally be an *Excavated Surface*. Consequently, artificial hard material *exposed at the Commencing Surface* could be below ground.

The removal of such material could be a completely different proposition to, say, removing concrete slabs at ground level, and the cost of removal will, in all probability, be equivalent to that of *artificial hard material not exposed at the Commencing Surface*.

Bill compilers should pay careful attention, therefore, to ensuring that item descriptions are clear, and contractors, no doubt, will be alert to the possibility of a misrepresentation of the item description.

Table 7.17 Billing of excavation items for crib retaining wall.

Earthworks					
<u>Excavation for foundations</u>					
Material other than topsoil, rock or artificial hard material; Retaining wall A					
A	maximum depth: 1-2m; Commencing Surface 300 mm above formation level	m3			
<u>General excavation</u>					
Topsoil					
B	maximum depth: not exceeding 0.25m	m3			
Material other than topsoil, rock or artificial material					
C	maximum depth: 2-5m; Commencing Surface underside of topsoil; Excavated surface 300 mm above formation level	m3			

Table 7.18 illustrates an item for the removal of reinforced concrete exposed at the Commencing Surface with respect to the foundation excavation for the crib retaining wall shown in Figure 7.7. The Commencing Surface is the Excavated Surface of the general excavation which is considerably below original ground level.

Table 7.18 Artificial hard material.

Earthworks					
<u>Excavation for foundations</u>					
Reinforced concrete exposed at the Commencing Surface					
A	maximum depth: 1-2m; Commencing Surface 300 mm above formation level	m3			

Two further descriptive features have been added to the Second Division in order to provide for the excavation of hazardous material. This is defined in Definition Rule D4 as *material whose excavation and disposal is governed by legislation* which the Work classification describes as *Controlled and hazardous material*.

It should be noted that Rule D4 includes *invasive plant species* in the definition of controlled and hazardous material. This provision should, therefore, be read in conjunction with Class D: *Demolition and site clearance* which also provides a Second Division descriptive feature for *invasive plant species*.

Risk issue

In Class D, Rule A3 requires item descriptions to include the *type of vegetation* and the *method of treatment*, and Rule C3 deems the *disposal of any vegetable matter remaining after treatment* to be included.

As one method of treatment of invasive plant species is removal by excavation, consideration needs to be given as to whether this should be dealt with in Class D or Class E.

In Class E, only Additional Description Rule A7 refers to *controlled and hazardous material*, with the requirement that *the nature of the material* shall be stated in item descriptions.

In view of the fact that Class D excludes the removal of materials below the Original Surface, it would seem to make sense to include surface treatment and removal of vegetation in Class D and any excavation requirement in Class E. The method of measurement is less than clear though.

Excavation items are deemed to include earthwork support, working space requirements and the removal of dead services (Coverage Rule C1 applies).

Risk issue

Coverage Rule C2 provides that items for excavation shall also *include the removal of existing pipes of any material or diameter*. There is no further detail given, and no mention is made of the removal of manholes and other chambers.

Presumably, the intention of Rule C2 is that the removal of drain pipes, ducts, culverts and the like are deemed included to the extent that they are present in an excavation, whether a general excavation, a foundation excavation or a cutting, etc.

Where existing drainage installations, statutory services and the like are known and require cutting off and removal or diversion, it must be assumed that a provisional sum for defined work would be included in the bill of quantities for such work. Alternatively, the work would be instructed as a variation (ICC/ICE conditions) or a compensation event (ECC).

Not included in excavation items is disposal which is classed in E 5 3 * *Excavation ancillaries*.

Disposal is deemed to be disposal off-site *unless otherwise stated* (Rule D5), and any double handling of excavated material must be *expressly required* to warrant measurement (Rule M14). Material to be disposed of on the site shall be stated in the item descriptions for *disposal of excavated material* (i.e. not in the excavation item), in accordance with Rule A10.

The volume of disposal is determined by the difference between *the total net volume of the excavation* and *the net volume of excavated material used for filling* (Rule M12).

Risk issue

Double handling of excavated material is determined by the *void formed in the temporary stockpile from which the material is removed* (Rule M13).

This is a site measurement as opposed to a quantity *computed net using dimensions from the Drawings*, and as such, Rule M13 must be considered a derogation of the rule stated in CESMM4, Paragraph 5.19.

7.15.2 Dredging

Dredging normally involves the removal and disposal of unwanted material submerged below a body of water. Whilst recognised as a special subdivision of earthworks (E 1 * *), CESMM4 offers no definition of what is meant by the word ‘dredging’, except:

- Measurement Rule M3 – where excavation is classed as *by dredging* in the bill of quantities, it shall be [ad]measured as *by dredging irrespective of the method of excavation* adopted by the contractor on-site.

Additional Description Rules A1 and A2 are clearly of crucial importance in describing dredging work, and not only should the body of open water be identified in the BQ Preamble, and similarly identified in item descriptions, but also the location and limits of excavation by dredging should be stated, unless this would be obvious.

There are many instances where *excavation by dredging* may be clearly classified as such – land reclamation, removal of silt from rivers and estuaries, cleaning of canals and ditches, creation of trenches in the seabed to accommodate pipelines, etc.

In other cases, the distinction is less clear, as excavation below bodies of water may be required without meriting the sobriquet of ‘dredging’. The removal of unacceptable material from within cofferdams in rivers, estuaries and harbours, for instance, may equally be classed as *excavation by dredging*.

Dredging to remove silt is measured as an excavation ancillary but only to the extent that (a) it is *expressly required* and (b) that the silt to be removed is that which has accumulated *after the Final Surface has been reached*. In all other cases, E 1 * * would apply.

The Work Classification requires that the quantity of *excavation by dredging* shall be measured in m³, and Measurement Rule M4 states that this shall be determined *from soundings* unless otherwise stated. Soundings are normally carried out using ultrasonic echo sounders in order to determine (a) the depth of a given point beneath the surface of a body of water and (b) the resulting depth after dredging work has been carried out.

Disposal is measured in accordance with E 5 3 *, but Rule A8 requires that disposal of excavation by dredging shall be distinguished in item descriptions as is the case for other excavation ancillaries.

Where the scope of dredging work is extensive, or not undertaken as work ancillary to civil engineering work, consideration might be given to formulating a ‘dredging-only’ contract. In this event, the usual conditions of contract might not be considered suitable, and the FIDIC standard Form of Contract for Dredging and Reclamation Works (2006) – the ‘Dredgers Contract’ or Blue Book – could be a more appropriate procurement choice.

The topic of dredging is discussed further in Chapter 9.

7.15.3 Filling

Filling is measured to structures, embankments, in general areas and to stated depth or thickness, in a range of stated materials, according to E 6 * *. It is deemed to include compaction (Rule C4).

The presumption is that filling material is to be *non-selected excavated material*, excluding topsoil or rock, unless otherwise stated (Rule D7). Filling with *excavated rock* is not measured unless expressly required, in which case the location of the work must be stated in item descriptions (Rule D8).

Bulk filling is not classed as *to stated depth or thickness* notwithstanding any specification requirements for the compaction of fill in particular layers.

In practice, there will be instances where there is an interface between filling to structures and filling to embankments. In the case of a bridge, for instance, the embankment is usually constructed

in two stages. Stage 1 is brought up whilst the bridge abutment is being constructed, and when this is finished, the embankment is completed behind the structure.

Consequently, Stage 2 of the embankment could be viewed as part of the embankment, but equally, it could be argued that there should be an item for filling to structures as the two operations are quite different and could be carried out using different plant. This situation is illustrated in Figure 7.8.

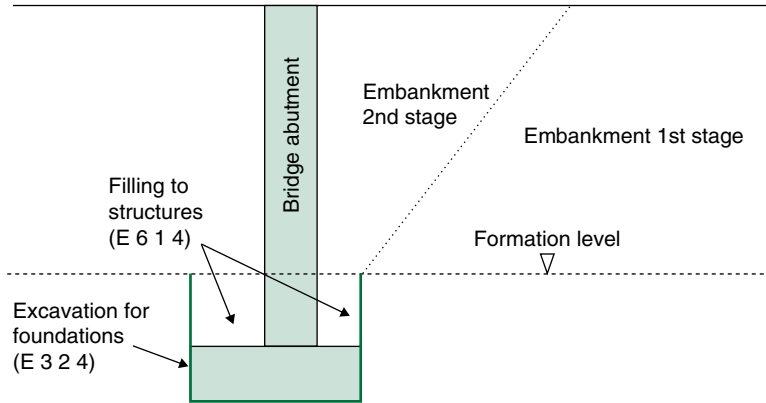


Figure 7.8 Filling to structures.

The resolution of this dilemma lies in Measurement Rule M16. This states that an item of filling around completed structures shall only be measured when the volume filled has also been measured as excavation in accordance with Measurement Rule M6. Rule M6 determines that the volume measured for the excavation of a structure shall be that which is *occupied by or vertically above* the structure.

Consequently, an item of filling to structures can only be measured as indicated in Figure 7.8 because, in all probability, the *excavation for foundations* item will have been measured from formation level (or from the top of the protection layer specified).

Imported fill must be identified in item descriptions, stating the material, in accordance with Rule A12. There is no rule for determining the volume of imported fill, but referring to Rule M12, it must be given as the difference between *the total net volume of the excavation* and *the net volume of [acceptable/suitable] excavated material used for filling*.

Risk issue

Where additional fill is required because of the settlement of underlying material or where fill has penetrated underlying material, the contractor is responsible for the first 75 mm of the 'ground loss' (Rule M18).

This is not an easy item to measure, even on-site, as the total 'ground loss' can only be derived from the total volume of fill less the volume of fill shown on the drawings. Even if this could be determined, a 'rough' calculation would have to be made to separate out the contractor's risk contribution (i.e. the first 75 mm of penetration).

If the fill is imported, then delivery records would be helpful, but determining the actual volume of excavated material would require very careful records of which excavations the fill came from, especially if some excavated material is to be disposed of off-site.

For rock filling in soft areas, the *volume* shall be measured *in the transport vehicles at the place of deposition*. Similarly, where fill deposited below water cannot be quantified, it shall be measured in the same way.

Risk issue

Measuring the **volume** of fill in a waggon is unrealistic because the material is in an uncompacted state. Even if a volumetric measurement were possible, it would be necessary to check every vehicle because the loads carried vary.

Where such circumstances may arise, Rules M20 and M21 should perhaps be revisited and arrangements made for quantities to be determined by weight.

A new item has been added to *Filling* in the form of *High energy impact compaction*. The *surface area to be treated* is measured in m², where the treatment is to existing ground (Rule M22), but where selected excavated material or imported material is to be compacted using this method of compaction, it is measured in m³. Item descriptions *shall state the type of compaction* (Rule A17) such as dynamic compaction using Cam (3-sided) or Pentagonal (5-sided) shaped impact drums.

A typical item is shown in Table 7.19.

Table 7.19 High energy impact compaction.

CLASS E: EARTHWORKS					£	p
Filling						
High energy impact compaction general fill; Dynamic compaction						
A	existing ground	10032	m2			

Risk issue

There is no rule as to how selected excavated material, or imported material, which is to be subjected to *high energy impact compaction*, is to be measured.

Imported material is delivered by the tonne, and selected excavated material, unless designated as double handling (Rule M13), is a bulked material of indeterminate volume.

7.15.4 Water

Where water affects the works, this is at the contractor’s risk, and there is no entitlement to a measured item for dealing with groundwater, or that from bodies of open water such as rivers and canals.

Paragraph 5.21 requires that bodies of open water shall be identified in the Preamble to the Bill of Quantities. A reference to a drawing shall also be given (presumably in the Preamble) showing the levels and boundaries of the water and the anticipated range of any fluctuations in levels.

The issue of groundwater raises the ‘thorny’ problem of borehole data and its reliability and also the spectre of contractual claims and compensation events should the data prove unreliable. This does not alter, however, the contractor’s obligation to keep excavations free from groundwater which will normally be specified in the contract (e.g. Specification for Highway Works, Clause 602).

Having said all that, there is an entitlement in Class E to a quantity for excavation *below a body of open water* pursuant to Measurement Rule M7. This is not a requirement of the Work Classification but emanates from Additional Description Rule A2.

The volume measured is specified in Rule M7 as:

- *The volume below water when the water surface is at the level (or the higher level of fluctuation if applicable) shown on the drawing...*

and Rule A2 requires that:

- The item description *shall identify the body of water.*

Figure 7.9 illustrates a typical situation where a bridge pier is to be constructed either side of a body of open water.

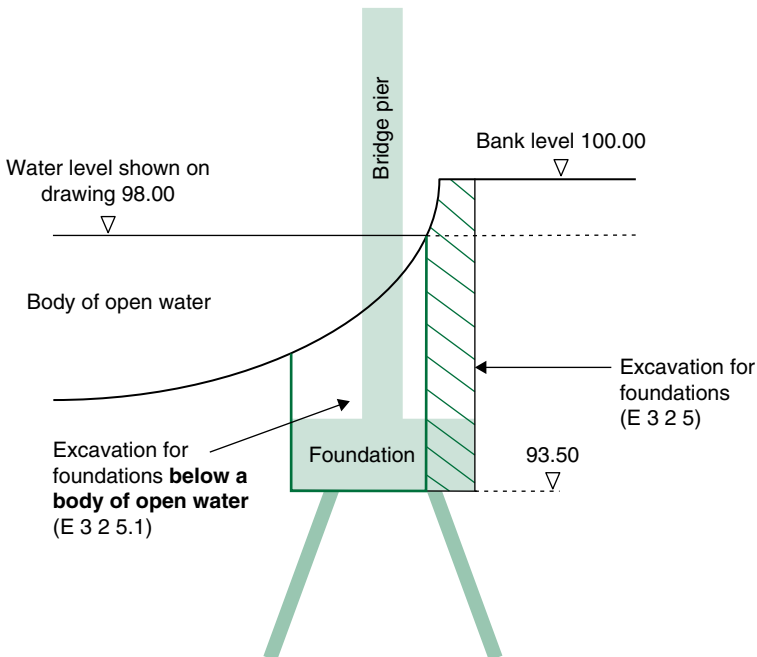


Figure 7.9 Excavation below a body of open water.

It can be seen that part of the excavation, whilst affected by the body of open water, is not below the water level shown on the drawing. Consequently, the shaded portion of the excavation cannot be described as *below a body of open water*. This means that two items are required for the same excavation, one with additional description to alert tenderers to the fact that some of the excavation work will take place below the indicated water level of a named body of open water.

The resulting bill of quantities items are shown in Table 7.20.

With reference to Table 7.20, it should be noted that there is no similar rule in Class P: *Piles* to those of Rules M7 and A2 in Class E. However, the requirements of Paragraph 5.21 must be respected, and it might be considered prudent to include the information referred to in Paragraph 5.21 in any relevant item for piling.

Table 7.20 Billing of excavation below a body of open water.

Earthworks					
<u>Excavation for foundations</u>					
Material other than topsoil, rock or artificial hard material					
A	maximum depth: 5-10m	52	m ³		
B	maximum depth: 5-10m; Below body of open water; River Gowey	156	m ³		

7.16 Class F: In situ concrete

Changes from CESMM3

- Provision of concrete:
 - *Standard mix* omitted
 - The word *mix* now largely replaced by *concrete*
 - Concrete classified to BS 8500 and BS EN 206-1 (D1, A1 and A2 refer)
 - New Additional Description Rules A3–A7
 - F 1 ** is *designed concrete* where the designer is responsible for ensuring compliance with standards (D2 refers)
 - F 2 ** is *designated concrete* where the concrete producer is responsible for the design (D3 refers)
 - F 3 ** is *standardised prescribed concrete* for simple structural non-reinforced applications (D4 refers); replaces old *standard mix* but mix designations remain the same in the Third Division (e.g. ST1, ST2, etc.)
 - F 4 ** is *prescribed mix* (although the definition rule refers to *concrete*) where the designer is responsible for the mix design (D5 refers)
 - F 5 ** is *proprietary concrete* for concrete that is *outside normal performance criteria* (D6 refers)
 - Now only three maximum aggregate sizes in the Third Division
- Placing of concrete:
 - New Definition Rules (D12 and D13) and Additional Description Rule (A11) relating to *sprayed concrete*
 - *Sprayed concrete* to be described as *other concrete forms* (D12 refers)
 - The horizontal line across the top of *other concrete forms* should have been extended into the Third Division. It makes no sense to describe *sprayed concrete* by cross-sectional area (also, Rule A11 refers to thickness not cross-sectional area)
 - The NOTE on page 40, which refers to Paragraph 5.10, should read 5.11

Notwithstanding substantial changes to the specification of concrete materials, Class F retains the distinction between the *provision of concrete* and the *placing of concrete* in the Work Classification.

The objective of this approach is to comply with CESMM4, Paragraph 2.5, which emphasises the need to distinguish between items of *work of the same nature*, carried out in different circumstances or locations, which *may give rise to different considerations of cost*.

All concrete, both supply and placing, is measured in m³, but there is a degree of ‘approximation’ to the calculation of volumes. Measurement Rule M4 includes a list of features, such as cast-in components, rebates, holes, etc., that are not excluded from the measured volume, and Rule M2 excludes nibs and external splays from the volume where <0.1 m² in cross section (i.e. 100 mm × 100 mm).

There are no item coverage rules in Class F, and great reliance is placed on Class A: *Method-related charges* to cater for major cost items involved in the provision and placing of concrete.

The intention is to derive a set of rates that are more transparent so that changes in concrete specification, or the conditions in which work is carried out, are more easily accommodated in the valuation of variations or compensation events. This is not to say that method-related charges are ‘ring-fenced’ and immune from admeasurement – far from it.

Class F relies heavily on Paragraphs 5.11: *Extent of itemisation and description*, and the NOTE on page 40 of CESMM4 emphasises that, where the location of concrete members may impact the method and rate of placing, this *may be stated* in the relevant item descriptions. Height above or below ground, size and rate of pour, mass per m³ of rebar, access limitations and so on can have considerable impact on concrete placing costs, and CESMM4 encourages bill compilers to think about such issues whilst, at the same time, not trying to ‘second guess’ the contractor’s working method.

Additional Description Rule A8 is a useful one for estimators because it is made clear that concrete is presumed to be filled into formwork unless *expressly required to be placed against an excavated surface*. The only exception to this rule is in the case of blinding.

Blinding is measured in m³ but Definition Rule D8 states that the thickness used for classification *shall be the minimum thickness*.

Risk issue

The minimum thickness of concrete in the Third Division of the Work classification is <150 mm. This is not especially helpful in relation to blinding where the waste factor due to ‘ground loss’ can be considerable.

A ground loss allowance of 12.5 mm in blinding 75 mm thick is approximately 17%, but this can vary between 8% and 25% for thicknesses of 150 mm and 50 mm, respectively.

A rule requiring the precise thickness of blinding would have been sensible.

Concrete features are described in the Third Division by thickness, except that columns, beams and steel casings are described by cross-sectional area. In each case, there is no requirement to state the precise thickness or cross-sectional area.

Figure 7.10 illustrates three situations covered by the rules in Class F:

- a) Rule M3 requires that attached columns shall be measured as walls, and Rule D9 states that the thickness shall exclude the additional thickness of the column.
- b) In the case of attached beams, these shall be measured as slabs with the thickness stated as the slab thickness (Rules M4 and D9 apply).
- c) Sprayed concrete is described as *other concrete forms* (Rule D12), and Rule A11 requires that item descriptions shall state:

- (i) The specification of the concrete.
- (ii) Whether it is reinforced.
- (iii) The minimum thickness.

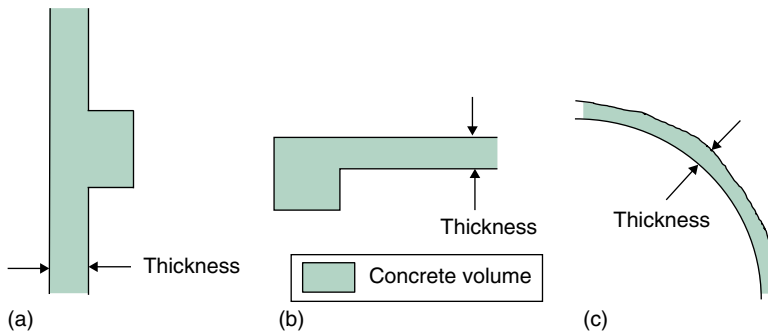


Figure 7.10 Concrete thicknesses. (a) Attached column, (b) attached beam and (c) sprayed concrete.

Reinforcement added to sprayed concrete, such as synthetic or steel fibres, is not classed as reinforcement (Class G 5).

CESMM4 distinguishes between ‘sprayed concrete’ in Class F: *In situ concrete* and in Class T: *Tunnels*, which measures sprayed concrete in connection with *in situ linings* to tunnels, shafts and other cavities. Another differentiating factor is that sprayed concrete in tunnels is measured in m^2 and that in Class F is to be given in m^3 .

Whilst the method of measurement is silent on the distinction, engineers will understand that ‘sprayed concrete’, variously known as *gunite*, *shot concrete* and *shotcrete*, is used for many purposes. Canal linings, reservoirs and dams, tunnel linings, diaphragm walls, piled wall facings and sea and river walls are amongst its many applications in addition to tunnelling using the New Austrian Tunnelling Method (NATM) (Sprayed Concrete Association).

Presumably *sprayed concrete* in Class F is intended to mean sprayed concrete other than that used in the NATM tunnelling process. Confusingly, Class F, Additional Description Rule A11, makes reference to *sprayed concrete support*, which is the very function of sprayed concrete in tunnel linings.

In any event, the method of measurement treats sprayed concrete differently in Classes F and T.

In Class T: *Tunnels*, Measurement Rules M2 and M5 state that *in situ linings* are measured either to *payment lines* or to the net dimensions shown on the drawings. There are no such rules in Class F, albeit Rule A11 requires the minimum thickness of *sprayed concrete support* to be stated in the item descriptions. In this case, it can only be assumed that the requirement does not apply to sprayed concrete in other applications.

Class F and Class T item descriptions are compared in Table 7.21.

Thicknesses of concrete in Class F are given in ranges and are not precise thicknesses. Therefore, similar work in the same location would be aggregated into one item provided the thickness of the various items is in the chosen range of thicknesses. The same principle applies to concrete components whose thickness varies but nonetheless remain within the dimension range (e.g. a tapering wall).

Where all work in an item has the same thickness, then the precise thickness, and not the range, would be given following the rule in Paragraph 5.15.

Table 7.21 Sprayed concrete in Class F and Class T.

	In Situ Concrete			
	<u>Placing of concrete - Reinforced</u>			
	Other concrete forms			
A	Sprayed concrete support; Grade 40; Reinforced; Minimum thickness 50 mm	m ³		
	Tunnels			
	<u>In situ lining to tunnels</u>			
	Sprayed concrete primary; Grade 40; Reinforced			
B	Diameter: 6 - 7 m; 50 mm thick	m ²		
	Sprayed concrete secondary; Grade 40; Reinforced			
C	Diameter: 6 - 7 m; 200 mm thick	m ²		

7.17 Class G: Concrete ancillaries

Changes from CESMM3

- G 6 * – reference to BS numbers omitted
- Old D6 omitted
- A9 – BS references omitted
- Footnote to page 43 omitted (i.e. permitting formwork to separate surfaces of concrete components of constant cross section to be measured by length as one item)
- However, G * 8 * and A5 relating to the measurement of formwork *for concrete components of constant cross section* remain
- Footnote to page 45, allowing *similar inserts which vary in size* to be combined within size ranges, omitted

The suffix ‘ancillaries’ in no way demeans the importance of Class G, which deals with the measurement of formwork, rebar, joints, post-tensioning and concrete accessories such as surface treatments, inserts and grouting base plates and the like. In keeping with their importance, the rules of measurement in Class G are well developed and understood, but certain items are nonetheless worthy of discussion in the context of this book.

7.17.1 Formwork

Barnes (1977) regards ‘formwork’ as temporary works treated as if it were permanent works. This has long been the tradition in UK methods of measurement, and almost paradoxically, contractors

are not only entitled to measured items in the bill of quantities for formwork, but they are also entitled to be paid for it even if it is not used or needed.

This is not to say that formwork is always measured, even if needed, notwithstanding Measurement Rule M1 which clarifies that, *where surfaces of in situ concrete...require temporary support, formwork shall be measured*. Consequently, Measurement Rule M1 must be read in conjunction with Rule M2 which provides the list of exceptions. These include:

- Edges of blinding <0.2m wide.
- Temporary surfaces formed at the contractor's discretion.
- Surfaces of concrete *expressly required* to be cast against an excavated surface.
- Surfaces of concrete cast against an excavated surfaces <45° to the horizontal.

Formwork is measured according to four categories of finish, five categories of orientation and five width ranges. It is surprising, in a 'neutral' method of measurement, that two of the width categories, G * 4 and 5, remain geared to UK plywood sizes (1.22m width). Many other countries, which are truly 'metric', have standard widths of 1.2m or 1.25m, and thus, the Third Division classification makes little sense. In any event, formwork is rarely the precise dimension of the finished concrete, and contractors are more than capable of working out formwork uses without the help of a method of measurement.

More to the point, the limitations of Class G: *Concrete ancillaries* relate to the fact that measurements are aggregated irrespective of the concrete element in question. This means that, on many occasions, tenderers are forced to remeasure the billed quantities in order to disaggregate formwork to the various structural elements. With a bridge, for instance, Class G does not separate G 1 4 * (formwork, rough finish, vertical) to abutment foundations, walls, wing walls, etc., and separate items are only measured should there be a requirement for a distinguishing 'finish' to the concrete.

Additional Description Rule A1 requires that *formwork left in* shall be so described. However, no distinction is made between formwork that has to be left in, because of the design or form of construction, and permanent formwork, that is, formwork that is designed to be left in (e.g. soffit formwork between bridge I-beams). In either case, reliance must be placed on CESMM4, Paragraph 5.11, in order to clarify such instances.

For concrete components of constant cross section, G * 8 *, there is a more useful Third Division classification relating to beams, columns, walls, etc.

In this case, the formwork required to create a concrete component may be measured and billed in linear metres, identifying the type of component in accordance with the Third Division classification, rather than having to measure the individual surfaces in linear metres or m².

The provisions of the Work Classification are to be read in conjunction with Additional Description Rule A5, which states that *the principal cross-sectional dimensions* are to be stated in the item descriptions, along with any other identifying feature.

Figure 7.11 illustrates (a) an in situ concrete column and (b) a beam, with the dim sheet attached, which shows:

- The width classification for the formwork relevant to each component.
- The dimensions for each (i.e. the column + the vertical sides of the beam).
- The total area of formwork measured.

Table 7.22 shows the completed BQ item (G 2 4 4).

A better way of measuring these components is by describing them as *components of constant cross section* (G 2 8 1 and G 2 8 2), as illustrated in Table 7.23, which compares the two methods of billing the same items. The snag here is that the item for the beam includes formwork to both the vertical sides and the soffit of the beam, and the estimator would have to perform a separate calculation in order to segregate the two types of formwork which would each be priced differently.

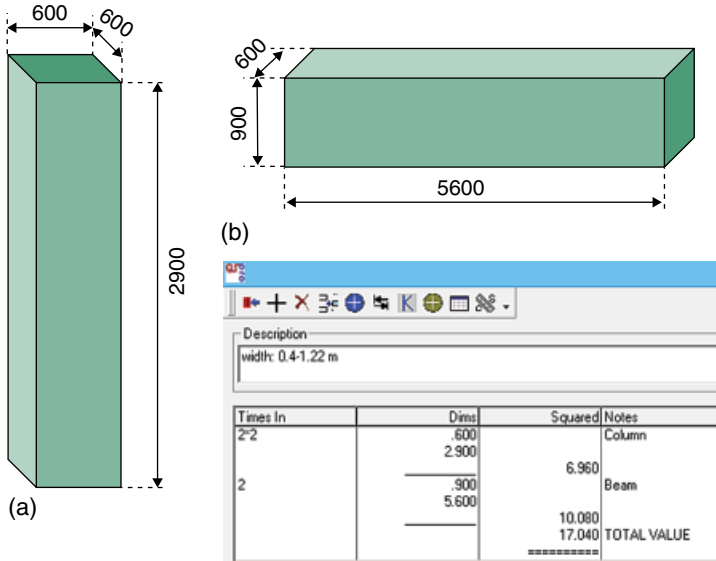


Figure 7.11 Width classification – 1. (a) Column and (b) beam.

Table 7.22 Width classification – 2.

Concrete Ancillaries					
<u>Formwork: fair finish</u>					
Plane vertical					
A	width: 0.4-1.22 m		17	m ²	

Risk issue

The billed item in Table 7.22 is not particularly helpful for pricing as not only will the formwork for each component be constructed differently, but the two components are in different planes with different support/falsework requirements.

If there were to be a number of these components in a structure, the tenderer would have to either (a) remeasure the formwork to derive quantities for both components or (b) split the billed quantities by proportion.

In the 'pressure pot' of tendering, method (a) could lead to mistakes/loss of valuable time and method (b) would be inaccurate.

Either way, this adds risk to the tender.

Of much more practical use in CESMM3 was the footnote to page 43, which permitted the separate surfaces of formwork, for components of constant cross section, to be measured by length as one item instead of by area. This meant that the sides and soffits of beams could each be

Table 7.23 Components of constant cross section.

A	Concrete Ancillaries	17 m ²
	Formwork: fair finish Plane vertical width: 0.4-1.22 m	

NB:

This item is for formwork to the column + the vertical sides of the beam.

Alternative description

B	For concrete components of constant cross-section beams; 600 mm x 900 mm	6 m
	C columns; 600 mm x 600 mm	3 m

NB:

Formwork to the vertical sides of the beam is measured separately from the formwork to the column.

given as separate items. This was particularly useful for attached beams and the like and permitted the various widths of formwork to be measured separately as illustrated in Figure 7.12.

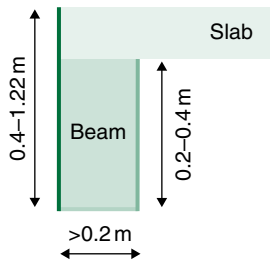


Figure 7.12 Separate surfaces of formwork.

Unfortunately, the page 43 footnote is no longer included in the fourth edition of CESMM. Whether this is by accident or design is known only to the authors of the method of measurement!

7.17.2 Reinforcement

Class G provides for three issues of importance in an otherwise featureless work classification for rebar:

- For bar reinforcement exceeding 12m, before bending, lengths shall be stated in item descriptions to the next higher multiple of 3 m – Rule A7.
- Items for rebar are deemed to include supporting reinforcement (chairs) – Rule C1.
- Supports to top reinforcement are to be included in the quantity of rebar measured – Rule M8.
- The areas of fabric reinforcement measured are exclusive of laps – Rule M9.

7.17.3 Joints

Measurement Rule M10 stipulates that joints shall be measured only where expressly required. Joints that require support during concrete casting are classed as *formed joints*, whereas other joints are *open surface joints* (D7 refers). Consequently, a horizontal joint in a concrete wall is an *open surface joint*, unless it is a construction joint, when it shall not be measured. A vertical joint in a floor slab is a *formed joint*.

Formwork to joints is deemed included in the item (Rule C3).

7.17.4 Post-tensioned prestressing

Concrete members that require post-tensioning on-site may be cast in situ or precast, and this is recognised in the Second Division of G 7 * *. The casting of in situ concrete components is measured in Class F: *In situ concrete*, and the supply of precast concrete components is measured in Class H: *Precast concrete*.

Coverage Rule C5 states that items for prestressing shall include ducts and grouting, and Rule A12 requires details of the component (to be stressed), tendons and anchorages to be stated in item descriptions. The jacking process is measured separately under G 7 5 0.

7.17.5 Concrete accessories

A variety of in situ concrete finishes is measured in G 8 including trowelling and applied finishes. Surface treatments of already formed surfaces, such as bush hammering, are also included.

Granolithic finishes are deemed to include materials, joints and formwork and surface treatment (Rule C6).

Linear and other inserts in in situ concrete seemingly cannot be combined within a size range owing to the omission of the footnote on page 45 of CESMM3.

7.18 Class H: Precast concrete

Changes from CESMM3

None

Class H: *Precast concrete* is chiefly concerned with the supply and fixing of large concrete units manufactured off-site, such as bridge beams, bridge deck slabs, subways, culverts, etc.

Precast concrete units are defined as *cast other than in their final position* (Rule D2), but where concrete items are precast on-site, Definition Rule D3 determines that they shall be measured as *in situ concrete* where:

- The reason for precasting is not to obtain multiple uses of formwork.
- The nature of the work is characteristic of in situ concrete albeit the cast unit has to be moved into its final position.

Figure 7.13 illustrates the point, where a bridge is to be constructed to one side of a railway line and then slid into its final position during a line possession.

The bridge would be measured as in situ concrete, with items given in Class A for the temporary works associated with the slide shown in Figure 7.13 (Rule D3 refers). Rule D3 implies that the



Figure 7.13 Bridge slide.

bill compiler is responsible for inserting the Class A Method-related charge, whereas Class A Rule M5 states that it is the tenderer's responsibility in accordance with CESMM4 Section 7: *Method-related charges*.

Class H 6 0 * and H 7 0 0 respectively distinguish between *segmental units* and *units for subways, culverts and ducts*. There are no Second and Third Division features with either, but whilst H 7 0 0 is fairly clear, there is no direction as to what is meant by H 6 0 *: *Segmental units*.

Segmental units are clearly not *units for subways, culverts and ducts*, despite being ‘segmental’, and thus, it must be assumed that H 6 0 * refers to sectional retaining walls, crib-type retaining walls, precast concrete overfilled arch structures, etc., but not concrete, masonry or artificial stone blocks which are measured under Class U.

Equally, however, H 6 0 * could refer to segmental precast concrete bridge units. These items are very large, normally of box girder construction, with a widened top flange, which are stressed together with wire tendons and/or Macalloy bars to form the completed structure. The top flange forms the full width of the carriageway, and they are usually cast on, or close to, the construction site.

The reasoning to class segmental bridge units as ‘precast concrete’ is that they are cast on or near to the site because of their size and weight rather than as a function of formwork cost efficiency.

Segmental units are classified in the Third Division according to which range their individual mass falls in (D1 also refers) and are enumerated (nr). However, Rule A4 overrides this by requiring the cross-section type and principal dimensions to be stated. The Third Division classification does not apply to *units for subways, culverts and ducts*, however, but the provisions of Rule A4 apply equally to both.

Units for subways, culverts and ducts, on the other hand, are measured in linear metres with the length being calculated as *the total length of identical units* (Rule M1 refers).

Risk issue

Precast concrete structures, such as box culverts, subways, overfilled arch bridges and short-span underbridges are of ‘proprietary’ manufacture, and thus, for public sector projects, this raises the issue of EU-inspired legislation that prohibits the creation of a ‘barrier to trade’ (see Chapter 8).

The MMHW deals with this issue in a somewhat convoluted way by using ‘designated outlines’ to define the location, but not the specification, of proprietary structures so that they may be designed by the contractor.

There is no similar provision in CESMM4, and bill compilers should be aware of the need to comply with legislation by not allowing one manufacturer an unfair advantage over others. Consideration might be given, therefore, to avoiding cross-section types and principal dimensions of proprietary structures where this information might identify, or be deemed to favour, a particular manufacturer.

7.19 Class I: Pipework – pipes

Changes from CESMM3

- Addition to Measurement Rule M5 making reference to pipes in dual trenches
- **NB:**

Coverage Rules C1 and C2 in CESMM3 have been omitted in CESMM4

These are key coverage rules that determine what is deemed included in item descriptions in Class I

This must be a mistake¹ as neither Class I nor Class L 2 * * make sense without C1 and C2

The heading beneath the class title says what is included and excluded, but this does not have the status of a coverage rule

¹ This book is written on the basis that Coverage Rules C1 and C2 apply:

C1	C2
Items for pipes shall be deemed to include the supply of all materials by the contractor unless otherwise stated. Items shall be deemed to include pipe cutting	Items for pipes <i>in trenches</i> shall be deemed to include excavation, preparation of surfaces, disposal of excavated material, upholding sides of excavation, backfilling and removal of dead services except to the extent that such work is included in Classes J, K and L

Source: CESMM3

The three divisions of Class I provide for the provision, laying and jointing of pipes, including those described as *not in trenches*, and for excavation and backfilling of pipe trenches.

Coverage Rule C1 confirms that the contractor's rates shall be deemed to include for the supply of all materials, but this is tempered with the exclusion of work included in Classes J, K, L and Y in the Class I heading. Consequently, Class I items do not include for pipe bedding, for special backfills or for the supply of pipe fittings or for the reinstatement of trenches, etc. This is emphasised in Coverage Rule C2.

In the Second Division, ranges of nominal bore are provided, but this is overridden by Additional Description Rule A2 which states that the nominal bores of pipes shall be stated in item descriptions.

The Commencing Surface for excavation shall be identified in items, except where this is the same as the Original Surface, but in both cases, the commencing surface adopted for preparation of the bill of quantities shall be adopted for admeasurement (Rule M1).

There are various approaches to measuring the depth of pipe trenches:

- NRM2 – the average depth between manholes irrespective of maximum depth
- MMHW – the arithmetic mean of depths measured every 10 m and terminal (i.e. short) lengths

The CESMM approach is quite different to either of these.

Depths of pipe trenches are categorised in the Third Division in depth bands – not exceeding 1.5 m, 1.5–2 m, 2–2.5 m, etc. – and are measured from the Commencing Surface to pipe invert (Rule D1). Average depths are not used in CESMM.

Consequently, for any given length of pipe between two manholes, the length(s) of pipe occupying each depth category or zone shall be measured and identified in the bill items. This is illustrated in Figure 7.14.

From Figure 7.14, it can be seen that the first 8 m of pipe, starting from the outfall end, lies within the 2–2.5 m depth zone and the next 27 m falls within the 2.5–3 m band and so on. The depths of pipe in the run from manholes 4–5 are all determined in this way, and it is by this process that the pipe runs are categorised. This is shown in Figure 7.15, which displays the dim sheet for the 2.5–3 m depth category, that is, a total of 57 m. Another 28 m lies in the 2–2.5 m depth band as shown.

The item descriptions and quantities are billed as shown in Table 7.24, where it can be seen that:

- The location of the group of items is indicated (Class I, Rule A1, refers).
- The nominal bore, the materials and pipe joint type is stated.

When measuring and describing pipework, it is vital to appreciate the role of Additional Description Rule A1 which is the means by which important information is conveyed to tenderers:

- a) The location of pipework.
- b) The type of pipework, in each item or group of items.

The whole point of the CESMM approach is to alert tenderers to risk, so that appropriate allowances can be made in the tender.

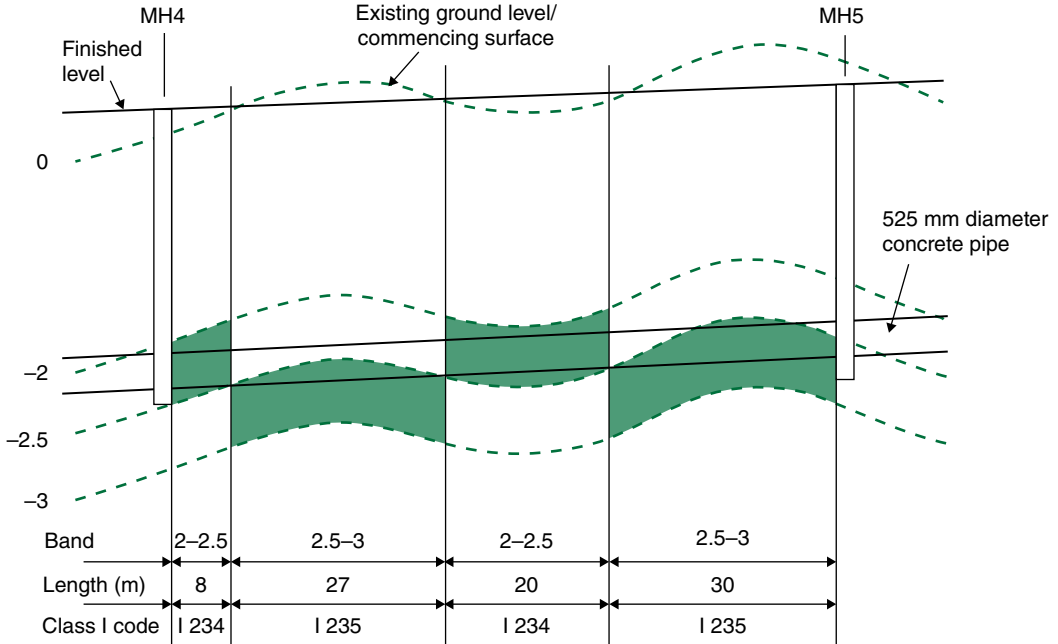


Figure 7.14 Pipework depth categories – 1.

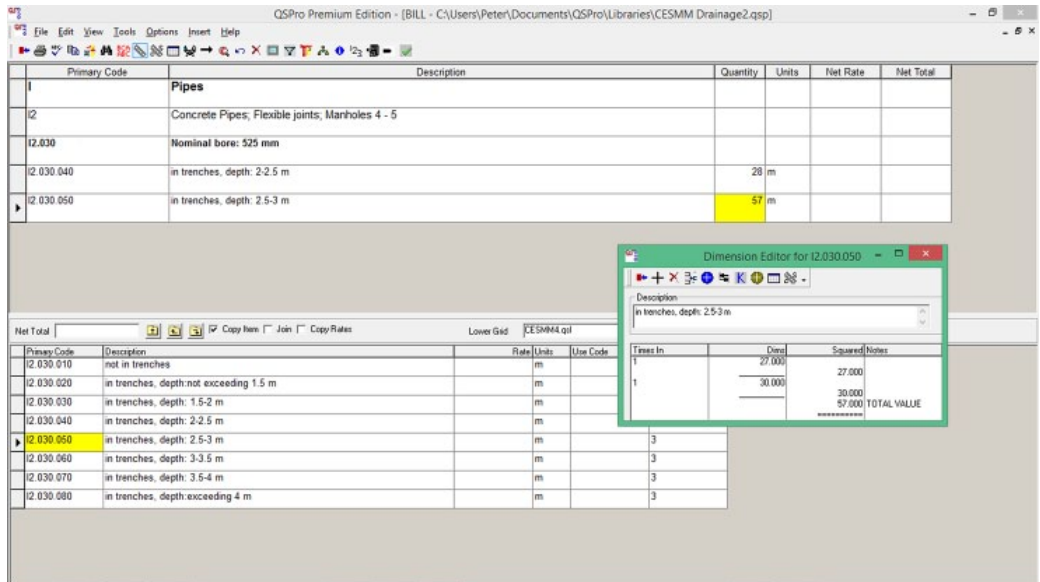


Figure 7.15 Pipework depth categories – 2.

Different types of pipework, in different locations, will affect access requirements, working methods, choice of plant, temporary works and output of the drainage gang. The bill compiler must exercise considerable judgement in deciding how to comply with Rule A1, as the method of measurement provides no guidance.

Table 7.24 Pipework depth categories – 3.

Pipes					
<u>Concrete Pipes: Flexible joints: Manholes 4 - 5</u>					
Nominal bore: 525 mm					
A	in trenches, depth: 2-2.5 m	28	m		
B	in trenches, depth: 2.5-3 m	57	m		

Grouping work in live sewers, drain runs subject to tidal influence, work in live carriageways, gully connections and branches for future development are just some of the many ways to individualise item descriptions and help the estimator to price the work accurately.

Class I items, whilst composite in nature, are not complete items. Pipework supports and protection, for example, are measured elsewhere (L * * *), for instance, as illustrated in Table 7.25.

Table 7.25 Pipework supports and protection – 1.

Pipes					
<u>Concrete Pipes: Flexible joints: Manholes 4 - 5</u>					
Nominal bore: 525 mm					
A	in trenches, depth: 2-2.5 m	28	m		
B	in trenches, depth: 2.5-3 m	57	m		
Supports and Protection, Ancillaries to Laying and Excavation					
<u>Haunches</u>					
Imported granular material					
C	nominal bore: 300-600mm	85	m		

Items for pipe bedding, haunches and surrounds are required to state:

- The material used (Rule A3).
- Depth of beds (Rule A3).
- The nominal internal diameter of the pipe (Rule D3), notwithstanding the Third Division classification.

The rule requiring the depth of beds to be stated is not clear and not very helpful either. It could be taken to mean the depth of beds only (L 3 * *) or the depth of the beds beneath haunches (L 4 * *) and surrounds (L 5 * *) as well as the depth of beds (L 3 * *). This part of Rule A3 is

somewhat academic, however, as estimators will invariably search for standard details on the drawings, or make reference to other standard details, for the bedding requirements for different types and diameters of pipes.

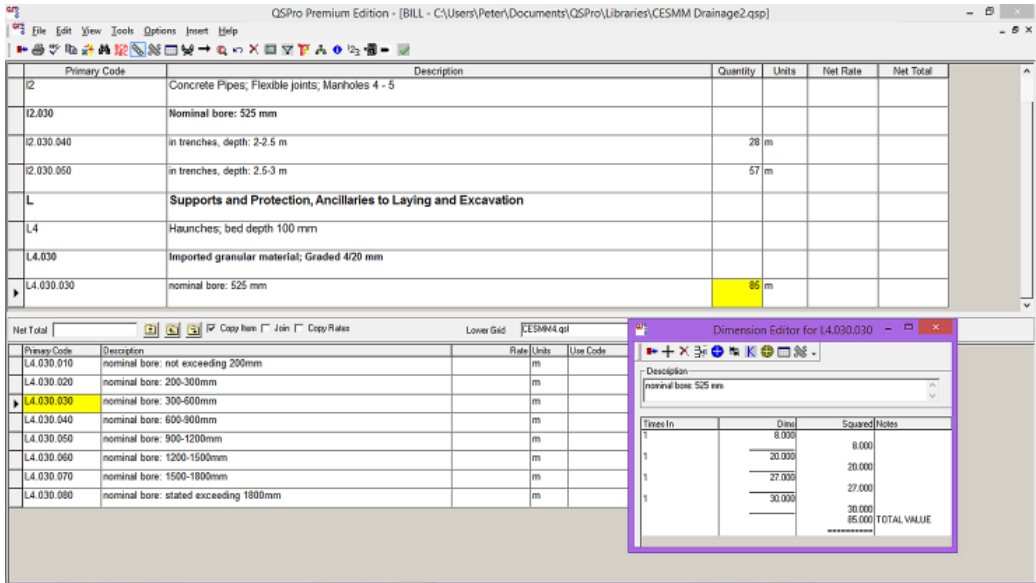


Figure 7.16 Pipework supports and protection – 2.

It can be seen from Figure 7.16 that the pipe support and protection item is ‘anded-on’ from the foregoing pipework items and that the billed item includes the type of material, the bed thickness and the nominal pipe diameter as illustrated in Table 7.26.

Table 7.26 Pipework supports and protection – 3.

Pipes				
Concrete Pipes; Flexible joints; Manholes 4 - 5				
Nominal bore: 525 mm				
A	in trenches, depth: 2-2.5 m	28	m	
B	in trenches, depth: 2.5-3 m	57	m	
Supports and Protection, Ancillaries to Laying and Excavation				
Haunches; bed depth 100 mm				
Imported granular material; Graded 4/20 mm				
C	nominal bore: 525 mm	85	m	

Backfilling of pipe trenches with material other than excavated material is measurable but not in Class I. Pursuant to Class I, Rule M2:

- Filling of French and rubble drains shall be measured in Class K.
- Backfilling with material other than that excavated from trenches shall be measured according to Class L.

However, backfilling of pipe trenches above or below the Final Surface shall only be measured where it is *expressly required* (Class L, Rule M7). The words *expressly required* can have two meanings:

- a) Shown on the drawings as being required.
- b) Instructed by the contract administrator during construction.

Risk issue

The difference between (a) and (b) is that admeasurement of items shown in the contract documents would similarly *be computed net using dimensions from the Drawings* (CESMM4, Paragraph 5.19), whilst items instructed by the contract administrator would be variations or compensation events and would, therefore, be subject to the contract conditions as regards the valuation of these items.

Items for backfilling above the Final Surface with concrete, or other stated material, and for excavation and filling below the Final Surface, are measured in m³ and according to Class L, Rules M4–7 and D1, the latter determining the nominal trench width used to calculate the volumes.

The volume of backfilling above the Final Surface, excavation being included in Class I items, is calculated by multiplying together *the average depth and length of the material ... backfilled and the nominal trench width*. Note reference to the *average depth* and not the depth categories in Class I.

Whilst there is no rule, it would seem logical to measure the average depth from the Commencing Surface to the top of pipe bedding/haunch/surround. Strictly speaking, for beds and haunches, this would necessitate a deduction for the space occupied by the pipe, but there is no measurement rule requiring this, save for CESMM4, Paragraph 5.19, which states that *the quantities shall be computed net ... from the Drawings*.

Sample BQ items for Class L backfilling to pipe trenches are provided in Table 7.27.

Table 7.27 Backfilling trenches – 1.

Supports and Protection, Ancillaries to Laying and Excavation					
<u>Extras to excavation and backfilling</u>					
In pipe trenches					
C	backfilling above the Final Surface with Clause 803 Type 1 Unbound Mixture	43	m ³		
D	excavation of natural material below the Final Surface and backfilling with concrete ST1	5	m ³		

The dim sheet for the Class L 1 1 6 item (backfilling with sub-base) is shown in Figure 7.17 where it can be seen that an estimated length of 18 linear metres of backfill (from a total of 28 m + 57 m = 85 m) is *expressly required*. This has been multiplied by the nominal trench width (525 mm + 500 mm (see Rule D1) = 1.025 m) and the average depth to the top of the pipe haunching.

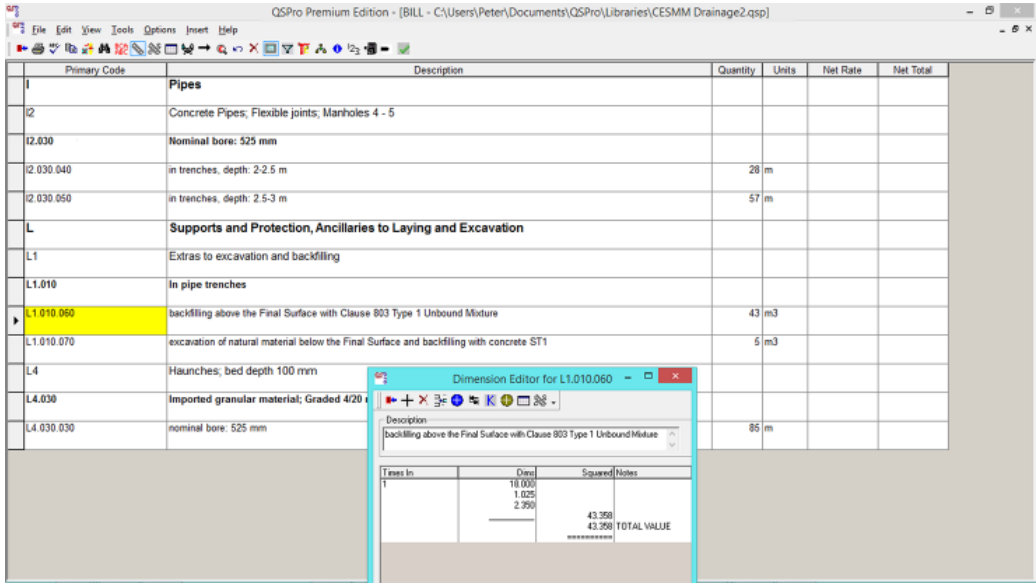


Figure 7.17 Backfilling trenches – 2.

The measurement of excavation and filling below the Final Surface is a straightforward calculation of length × nominal trench width × average depth (Class L, Rule M4). This is basically a provision for soft spots in trenches and, as such, must be considered ‘provisional’.

Risk issue

There is no concept of ‘provisional’ quantities in CESMM4 but, clearly, a measured item for soft spots cannot be viewed as being ‘estimated’ in the same sense as other measured items in the Bill of Quantities (CESMM4, Section 1, Definition 1.5, refers).

In circumstances where (a) there are no soft spots found or (b) the quantity allowed is proved to be significantly inadequate, a contractual issue may arise as to whether the method of measurement has been respected and/or whether the quantities have been misrepresented in the bill of quantities.

Contractors will, no doubt, view Class L items L 1 1 7–8 with suspicion and price them accordingly!

7.20 Class J: Pipework – fittings and valves

Changes from CESMM3

- Additional Description Rule A1 – reference to British Standard specifications omitted

Class J provides for the measurement of fittings and valves.

Pipe fittings are accorded seven First Division features and eight in the Second Division. *Valves and penstocks* are measured under J 8 * 0.

These items are ‘supply and fix’ as determined by Coverage Rule C1. However, the length of pipes (measured in Class I) are measured over fittings and valves (Class I, Rule M3) with the consequence that fittings and valves are effectively ‘extra over’ the pipes to which they relate.

Straight specials (J * 8 *) or ‘rocker pipes’ are defined in Class J, Rule D2, as being a length of pipe *cut to length or made to order*. They are not measured unless *expressly required* in the contract. Straight specials do not occur where the contractor is obliged to cut pipes to accommodate pipe runs that are not multiples of standard pipe lengths (Rule M2), but where they are specified, items are *deemed to include cutting* (Rule C3).

In common with Class I, the nominal bore of pipe fittings shall be stated in item descriptions in place of the nominal bore ranges (e.g. 200–300mm) given in the Third Division of the classification.

For manholes and other chambers with a backdrop, Rule M1 states that the associated pipe fittings are included with the Class K item (K 1 * * and K 2 * *).

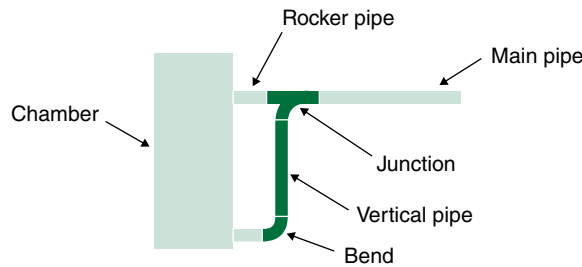


Figure 7.18 Backdrop.

However, Figure 7.18 indicates that the junction on the main pipeline at the top of the backdrop is part of both the backdrop and the pipeline. In this case, Class I, Rule M3, states that the *lengths of pipes in trenches shall ... exclude lengths occupied by pipes and fittings comprising backdrops to manholes*. Thus, the length of the junction would be excluded from the length of pipe between manholes.

7.21 Class K: Pipework – Manholes and Pipework Ancillaries

Changes from CESMM3

None

7.21.1 Manholes, chambers and gullies

Manholes, chambers and gullies are provided for in Class K, along with French drains and the like, ducts, metal culverts, crossings and reinstatements.

Manholes and other chambers are enumerated and described according to their type (with or without backdrop) and depth within the Second and Third Divisions. In practice, it is likely that standard details of different chambers will be provided, and where this is the case, reference numbers must be included in item descriptions according to Additional Description Rule A1.

Depths are measured from the tops of covers to invert, or tops of base slabs in catchpits and the like. There is no reference to a Commencing Surface for these items, but as excavation is likely to represent a relatively small proportion of the cost, normal practice would be to assume the full depth for the volume calculation when pricing such work.

7.21.2 Piped french and rubble drains

Piped French and rubble drains are measured in two Classes:

- a) Class I provides for excavation and pipe laying (M1) (Table 7.28 refers). The location or type of pipework shall be stated according to Class I, Additional Description Rule A1, and this is stated in Table 7.28 as ‘French drains’.

Table 7.28 Class I – Piped French and rubble drains.

Pipes					
<u>Clay Pipes</u>					
Nominal bore 150 mm; French drains					
A	in trenches, depth: not exceeding 1.5 m	227	m		

- b) Filling is measured in m³ in Class K4, with details of the filling material given in the description (A4) (see Table 7.29).

Table 7.29 Class K – Piped French and rubble drains.

Pipework - Manholes and pipework ancillaries					
<u>French drains, rubble drains, ditches and trenches</u>					
Filling French and rubble drains with graded material					
C	Type B 20/40 mm graded filter media	176	m ³		

There is no measurement rule in Class K for calculating the volume of filling to French drains and the like.

However, it would be difficult to argue against the application of rules provided in Class L which, *inter alia*, define the nominal trench width. For a 150 mm diameter French drain, the nominal trench width would be 150 mm + 500 mm = 650 mm, as illustrated in Figure 7.19.

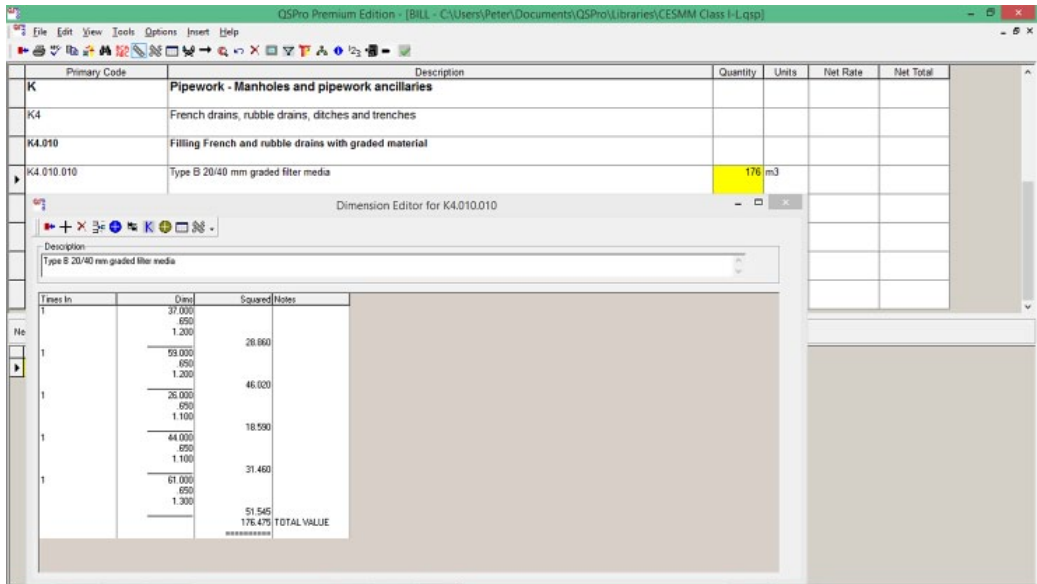


Figure 7.19 Filling to piped French and rubble drains.

Risk issue

The separation of the excavation and filling of French/rubble drains creates a problem for the estimator when there is more than one diameter of piped trench.

This is because it is very difficult to relate the volume of filling to the length of piped trench in order to calculate the additional excavation and waste factor (i.e. the additional excavation, disposal and filling for a trench of a given depth and nominal width) due to the width of the excavator bucket.

The waste factor for filling a trench 1 m deep (150 mm diameter pipe) is given below and also compared to that for a 225 mm diameter pipe.

Pipe diameter mm	Bucket width	Nominal width	Waste calculation
150	750 mm	150 mm + 500 mm = 650 mm	$\frac{750 - 650}{650} \times 100 = \mathbf{15.38\%}$
225	900 mm	225 mm + 500 mm = 725 mm	$\frac{900 - 725}{725} \times 100 = \mathbf{24.14\%}$

In Class K, piped French drains and rubble drains are distinguished from un-piped rubble drains (K43*). Such items are measured in linear metres, with a stated cross-sectional area, and are deemed to include excavation, earthwork support, disposal, etc. in accordance with Coverage Rule C1 (Table 7.30 refers).

The filling of un-piped rubble drains, however, is measured under K410 or K420 in m³.

Table 7.30 Un-piped rubble drains.

B	Trenches for unpiped rubble drains cross-sectional area: 0.75 - 1 m ²	174 m			
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7.21.3 Vee ditches

Vee ditches are classed as *lined* (K 4 7 *) or *unlined* (K 4 6 *) and are measured in linear metres within a stated cross-sectional area.

Whether or not vee ditches are lined, *the cross-sectional area shall be measured to the Excavated Surface* (Rule M2), that is, the underside of any lining. Details of any linings are to be stated in the item description (Rule A5) which shall include the materials and dimensions of the linings. As illustrated in Figure 7.20, this can involve several different linings, sub-bases and membranes in the one item.

Part 2



Figure 7.20 Lined vee ditches.

Risk issue

In the absence of any coverage rule in Class K, it can only be assumed that the items for lined ditches shall include the lining itself and any membranes.

The excavation, disposal and preparation of surfaces are deemed included by Coverage Rule C1.

7.21.4 Ducts and metal culverts

Ducts and metal culverts are measured in linear metres in accordance with the rules for pipes in Class I (Class K, Rule M3, refers). Such items are measured as *in trenches* or *not in trenches* with those in trenches classified according to the same depth banding as Class I: *Pipework – Pipes*.

Additional Description Rule A6 stipulates that the rules of Class I (presumably the additional description rules thereof) shall apply to ducts and metal culverts, and therefore, pipe diameters and other details shall be given in item descriptions.

According to Definition Rule D1, the lengths of multi-pipe ducts are calculated along a centre line which is taken as being a line equidistant from *the inside faces of the outer pipe walls*. This may not represent the true centre line of the trench.

7.21.5 Crossings and reinstatement

Where pipelines cross specified physical features, a measurable item is created for *crossings* (K 6 * *).

Road and rail crossings are not listed in the Second Division features because:

- a) Road crossings and the like are measured under K 7 1–4 *.
- b) Rail crossings would normally be subject to *special pipe laying methods* and would thus be measured under L 2 * *.

Items for crossings of the physical features listed in the Second Division include reinstatements unless otherwise stated (Coverage Rule C6) but:

- Crossings of streams <1 m wide shall not be measured (M5).
- Where linings are broken through any reinstatement shall be stated in the item description (A7).

Crossings of rivers, streams and canals are classified according to their widths measured at the water level shown on the drawings (D6).

Reinstatements are measured for pipes, ducts and metal culverts (M6) in linear metres (K 7 * *).

The length of reinstatement is measured along the centre line (Class K, Rule M7), and lengths include manholes and chambers (M7). The centre line for multiple pipes, ducts and metal culverts is defined in Class K, Rule D1, as *the line equidistant between the inside faces of the outer pipe walls*, as illustrated for a three-way duct in Figure 7.21.

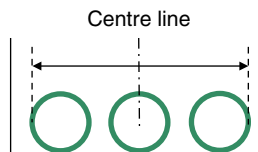


Figure 7.21 Multiple pipes, ducts and metal culverts.

Logic would seem to imply, therefore, that reinstatements are measured along the centre lines of pipes, ducts and metal culverts irrespective of the number of pipes in the trench. This makes practical sense but regard must also be paid to Class K, Rules M3 and D5, which state that Class I ‘rules’ (NB: measurement, definition, coverage and additional description rules, not the Work Classification) shall apply to ducts and metal culverts. This would seem to imply that the centre line measurement is solely a mean length but that each pipe in the trench is nevertheless measured.

Therefore, for three 100 mm pipes in a trench, the quantity of pipework is $3 \times$ the length along their centre line (the outer pipes may be longer or shorter than each other due to the angle or radius of the trench).

Consequently, the measurement of reinstatement is less than clear. On the one hand, Class K, Definition Rule D1, provides a rule regarding the centre line for multiple pipes, ducts or culverts,

but on the other hand, Class I ‘rules’ also apply to pipes, ducts and metal culverts which state that *the length of the pipe*, not the length of the trench, shall be measured where multiple pipes are *expressly required*.

Therefore, where there is more than one pipe in a trench, care needs to be taken with measuring associated reinstatements, because Rule D7 states that the classification of bore in the Third Division is to be taken as the *maximum nominal distance between the inside faces of the outer walls of the pipe, duct or culvert to be installed*.

This definition rule is clearly written in the singular (e.g. *the pipe*) with the implication that a reinstatement item is measurable for each pipe in a dual trench or each pipe in a multiway duct. This is emphasised in Class I, Measurement Rule M3, which states that *where more than one pipe is expressly required to be laid in one trench, the length measured shall be the length of the pipe* (i.e. each pipe).

Risk issue

As there is no provision for stating the width of reinstatements, save to include the bore of the pipe as per Definition Rule D7, or any clear rule as to how reinstatements are to be measured for trenches with multiple pipes, contractors would be wise to verify the quantities stated in the BQ with the drawings.

The danger is that they may ‘overprice’ these items when there is more than one pipe in a trench, and in a city centre sewer replacement scheme, the extent of reinstatement could be considerable.

7.22 Class L: Pipework – supports and protection, ancillaries to laying and excavation

Changes from CESMM3

None

Class L provides a work classification for special pipe laying methods, such as thrust boring and pipe jacking, and for the provision of supports and protection to pipes, ducts and metal culverts, as well as for cost significant items incidental to such work, including the excavation of rock and the excavation and filling of soft spots.

Coverage Rule C1 determines that items of work in Class L shall include excavation, disposal, earthwork support, backfilling, etc., except where such work is included in:

- Classes I, J and K.
- Extras to excavation measured in Class L.

Consider the item for pipe jacking in Table 7.31.

This item is measured in Class I (I 2 3 1), and thus, Coverage Rules C1 and C2 must be consulted to see what is deemed included as regards materials and excavation, supports to excavation, disposal, etc.

As I 2 3 1 is described as *not in trenches*, Coverage Rule C2 does not apply (C2 only applies to pipes in trenches), and thus, the item coverage in Class L must now be referred to.

C3 states that items for *special pipe laying methods* shall be deemed to include, *inter alia*, work associated with *special pipe laying methods* not included with the Class I item. As this

Table 7.31 Pipe jacking – 1.

	Pipes				
	<u>Concrete Jacking Pipes: Steel collar and elastomeric sealing gasket</u>				
	Nominal bore: 600 mm				
A	Pipe jacking beneath A492; MH3 - MH4; not in trenches	24	m		

has been described as *not in trenches*, it is regarded in C3 as an item for *provision, laying and jointing of pipes* and thus does not include excavation work.

The item must, therefore, be completed with a Class L item for *special pipe laying methods* as illustrated in Table 7.32.

Table 7.32 Pipe jacking – 2.

	Pipes				
	<u>Concrete Jacking Pipes: Steel collar and elastomeric sealing gasket</u>				
	Nominal bore: 600 mm				
A	Pipe jacking beneath A492; MH3 - MH4; not in trenches	24	m		
	Supports and Protection, Ancillaries to Laying and Excavation				
	<u>Special pipe laying methods</u>				
	Pipe jacking; MH3 - MH4				
B	nominal bore: 600mm	24	m		

With regard to *special pipe laying methods*, Class L, Measurement Rule M9, requires that such items shall only be measured where *expressly required*. This is echoed in Class I, Definition Rule D2.

It is likely that, in most cases, the decision as to whether to install pipes in heading, by pipe jacking or by thrust boring will be taken by the contractor – perhaps with some design responsibility – and not the bill compiler. In this event, the work would not be measured as *not in*

trenches (I * * 1), but additional description (Class I, Rule A1) would be given to alert the tenderer to the possibility that special methods could/should be considered.

The items of *extras to excavation and backfilling* (L 1 * *) are for the measurement of items of work which are additional to the items measured in Class I and in Class L 2 * *: *Special pipe laying methods*. They fall into two groups:

1. Items L 1 * 1–6.
2. Items L 1 * 7–8.

Items in the first group – excavation of rock, backfilling above the Final Surface, etc. – may be considered as ‘extra over’ the descriptive features in the Second Division (e.g. pipe trenches, manholes, pipe jacking) because they occur within the confines of the already measured items in Class I and Class L 2 * *.

Items in the second group – excavation and filling below the Final Surface – are ‘full value’ items because they are measured outside the confines of the items already measured in Class I and Class L 2 * *.

There is no definition of ‘rock’ in CESMM4, but when defined in the Preamble in accordance with Paragraph 5.5, such material shall be measured when expected or encountered in pipe trenches, manholes, headings, thrust boring and pipe jacking.

The volume measured is determined by Measurement Rules M4–M6 and Definition Rule D1:

Volume	Nominal trench width
<p>M4 In pipe trenches: The average depth × average length × nominal trench width of the material removed or backfilled</p>	<p>D1</p> <ul style="list-style-type: none"> ■ The maximum nominal distance between the inside faces of the outer pipe walls¹ (d) + 500 mm where d < 1 m ■ The maximum nominal distance between the inside faces of the outer pipe walls¹ (d) + 750 mm where d < 1 m
<p>M5 In manholes or other chambers: The maximum plan area of the manhole or other chamber</p>	<p>¹This convoluted definition is needed in case there is more than one pipe in the trench.</p>
<p>M6 In headings, thrust boring and pipe jacking: Length × internal cross-sectional area of the pipe</p>	

In pipe trenches, the use of the word ‘nominal’ is important because it means ‘notional’ and not ‘actual’. Consequently, the quantities that might appear in the bill of quantities are based on a drawing or standard detail, and the quantities measured during admeasurement are not actual save that the average length and average depth are determined on-site.

In manholes and other chambers, the maximum plan area is not defined but is likely to be taken as including any concrete surround but not the space occupied by formwork.

In headings, thrust boring and pipe jacking, the wall thickness of the pipe is not taken into account when determining the volume.

Risk issue

For the contractor, the volumes given in accordance with M4–6 and D1 represent an under-measure, and due allowance needs to be made for additional excavation, disposal and filling:

- In pipe trenches:
 - When the bucket width of the excavator is greater than the nominal width of the trench
 - When the excavation process results in a wider trench excavation as it invariably does
 - When earthwork support creates an excavation wider than the nominal trench width
- In manholes and other chambers:
 - For the space occupied by formwork and earthwork support and for working space
- In headings, thrust boring and pipe jacking:
 - For the volume of the annulus of the pipe
 - For 'overbreak'
 - For the volume of specification tolerances

7.23 Class M: Structural metalwork

Changes from CESMM3

- Measurement Rule M6 amended to omit reference to BS 4360

Class M is the repository of fabricated structural steelwork where fabrication is measured separately from erection. Both are measured in tonnes, and both are categorised as members for bridges, members for frames and other members.

There is no specific mention of structural steelwork for buildings in Class M, and neither is Class M referred to in Class Z: *Simple building works incidental to civil engineering works*. There are some descriptive features listed in the Second Division that would suffice for a portal frame or simple trussed roof steel structure, but the list is not as comprehensive as that found in NRM2. In this regard, it may be necessary to adopt an alternative method of measurement for such works pursuant to CESMM4, Paragraph 5.4.

With the exception of plates and flats, fittings are not measured, but weld fillets, bolts, nuts, washers, rivets and protective coatings shall be included in the mass of members measured (Measurement Rule M4). Exceptionally, site bolts are measured under the erection items M 5–7, and items are deemed to include for supply and delivery to site as per Coverage Rule C3.

Anchorage and holding down bolts are measured items (M 3–4 8 0), but only for fabrication, with anchorages and holding down bolts being measured by the number of complete assemblies and enumerated (nr).

Additional Description Rule A6 provides that items for erection shall identify separate bridges and structural frames in descriptions and, *where appropriate*, parts of bridges or frames.

Surface treatments such as metal spraying, galvanising and painting carried out off-site are measured under M 8 * 0, with the materials and number of applications stated in the item description. Surface treatments carried out on-site are measured under Class V: *Painting*.

7.24 Class N: Miscellaneous metalwork

Changes from CESMM3

- C5 – items for *bridge bearings* to include for grouting beneath plates
- A3 – item descriptions for *bridge bearings* to state composition and materials of the bearing
- A4 – item descriptions for *tanks* to state the principal dimensions

Class N is for ‘odds and sods’ of metalwork not measured in other classes, and this is recognised in a long list of exclusions in the class heading. This is not to minimise the importance of items measured in this Class as the likes of bridge bearings, bridge parapets, stairways and handrails do not come cheaply.

The ‘odd’ nature of items in this Class is recognised in the First Division, where there are no groupings for the descriptive features offered in the Second Division.

For items of miscellaneous metalwork, great reliance is placed on Additional Description Rule A1 as well as upon drawings or standard details, to portray items that would otherwise require lengthy bill descriptions. This emphasises that, perhaps more than anywhere else in the method of measurement, civil engineering bills of quantities are not intended to fully describe the work in a project but that the BQ must be read in conjunction with the other documents that make up the contract to appreciate the full extent of the work involved.

Of particular note in Class N is the measurement of walings (N 2 5 0) and tie rods (N 2 4 0) in connection with piling work; the former is measured in linear metres and tie rods by number (nr) with items for tie rods deemed to include concrete, reinforcement and joints (Coverage Rule C4 refers).

Tanks – a new group of descriptive features in the Second Division – are to be enumerated within eight volume bands, with Additional Description Rule A4 requiring that the principal dimensions are to be stated. This is in addition to Rule A1 which requires full specification and other information to be provided as well.

New Coverage Rule C5 stipulates that grouting beneath bridge bearing plates is deemed included in item descriptions.

7.25 Class O: Timber

Changes from CESMM3

- None

Class O: *Timber* specifically excludes timber used for formwork, piling, rail work, tunnels and simple building works, etc. and thus is restricted to timber required for constructing jetties, marina decking, gangways, footbridges and the like. In fact, timber components (O 1–2 * *) are measured separately from timber decking (O 3–4 * 0), and each has a different unit of measurement.

Timber components are measured in linear metres with decking measured in m².

It would seem prudent to identify the structure to which the work measured in Class O relates albeit this is not required in the Work Classification. For instance, it would be helpful to tenderers to know that a measured quantity of timber components and decking relates to a particular jetty in a specific location, and thus, the provisions of CESMM4, Paragraph 5.11, might be considered appropriate.

Notwithstanding the Second Division categories, the nominal cross-sectional dimensions of timber components shall be given in item descriptions (Additional Description Rule A1), along with type and grade of timber, treatment details and surface finish (sawn, wrot).

Openings and holes are not deducted from the area measured for decking unless each opening/hole exceeds 0.5 m^2 (Measurement Rule M2). This includes gaps between decking boards, if specified.

Therefore, in a given area of decking 3 m wide with 12 mm gaps, the net effect of Rule M2 is that no deduction would be made as each gap is less than the threshold ($3\text{ m} \times 0.012\text{ m} = 0.036\text{ m}^2$). The deduction is not cumulative but is for each opening or hole.

No labours (fixing, cutting, boring, etc.) are measured to timber work in accordance with Coverage Rule C1, but fixings, such as straps, bolts, etc., are enumerated under O 5 * 0.

7.26 Class P: Piles

Changes from CESMM3

- *Preformed prestressed concrete piles* omitted from the First Division
- A7 – item descriptions for *preformed concrete piles* to state if they are *prestressed*
- New First Division item P8** for *stone columns* (C2 and A15 refer)

The description of work items for cast-in-place and preformed piling relies on the classification provided in the Third Division of Class P: *Piles*:

Bored/driven* cast-in-place piles		Preformed concrete piles	
■ Number of piles	nr	■ Number of piles of stated length	nr
■ Concreted length	m	■ Driven depth	m
■ Depth bored or driven	m		

*Using the FRANKI® pile system.

Bored or driven piles are reinforced and filled with in situ concrete, and preformed piles are precast off-site.

Groups of bored/driven piles (i.e. the same type/materials, diameter/cross section and location) are required by Measurement Rule M2 to be billed as follows:

- An item for the number of piles.
- An item for the concreted length.
- An item for the total depth bored or driven.

This is illustrated in Table 7.33.

In Table 7.33, the concreted length is measured according to Rule M3, this being the measurement from the *cut-off levels* to the *toe levels* expressly required. It will also be noted that:

- The maximum bored/driven depth is stated according to Definition Rule D1; this is the maximum depth of any pile in a group of piles.
- The structure to be supported is identified (Additional Description Rule A3).
- The *Commencing surface* is stated (also A3).

Table 7.33 Piles – 1.

<u>Bored cast in place concrete piles: Retaining wall B;</u> <u>Commencing surface 1m above Final surface</u>					
Diameter: 450 mm					
A	number of piles	18	nr		
B	concreted length	162	m		
C	depth bored or driven; maximum depth 12m	180	m		

For preformed piles, Rule M4 requires:

- An item for the number of piles.
- An item for the total depth driven.

This is illustrated in Table 7.34.

Table 7.34 Piles – 2.

<u>Preformed concrete piles: prestressed: Bridge 2;</u> <u>Commencing surface 300 mm above Final surface</u>					
Cross-sectional area: 0.05 - 0.1 m²					
A	number of piles; length 15m	14	nr		
B	depth driven	196	m		

The depth of pile driven is not necessarily given by the number of piles × length but is a function of the head and toe levels stipulated in the contract. It will also be noted in Table 7.34 that the preformed concrete piles are described as *prestressed* as required by Additional Description Rule A7, and the details required by Additional Description Rule A3 are also given in the item.

The Commencing Surface for the purpose of measurement is defined in Measurement Rule M1 as *the surface at which boring or driving is expected to begin*.

This requires the bill compiler to make a judgement as to where piling work is to start, which might not be the actual commencing surface on-site. Measurement Rule M1 further provides, however, that the measurement of completed work shall adopt the same commencing surface so that the contractor is not disadvantaged in terms of the final measured quantities, except to the extent that the choice of commencing level is conditioned by the working method adopted.

There is no ‘deemed included’ provision, or item coverage rule, for the supply of piles or the supply of concrete for cast-in-place piles. There is only the implication, in Additional Description Rule A1, that item descriptions shall include details of the *materials of which piles are composed*. Reinforcement to piling, on the other hand, is measured in Class Q: *Piling ancillaries*.

The new Class P category of *stone columns*, for foundations constructed using the vibro-displacement/vibro-replacement method, merits two measured items – one for the number of columns (P 8 * 1) and another for the total length (P 8 * 2). Additional Description Rule A15

requires that the diameter of stone columns shall be stated in item descriptions, notwithstanding the eight Second Division diameter ranges provided.

The same rules apply to stone columns as to piles:

- Commencing surface to be stated A3.
- Depth measurement – commencing surface to toe (M1).
- Identify structure to be supported (A3).
- Disposal of excavated material deemed included (C1).

Additionally, Coverage Rule C2 states that items for stone columns shall include for boring.

Table 7.35 illustrates a typical bill item.

Table 7.35 Stone columns.

<u>Stone Columns: Marina gangway raft foundation:</u> <u>Commencing surface 2m below Original surface</u>				
	Diameter 600mm			
C	Number of columns	80	Nr	
D	Length of columns	184	m	

The provision of an item for the number of piles and stone columns recognises the fixed cost of establishing and re-establishing the piling rig at each pile location. However, the mobilisation of the piling work, bringing plant to site and later removal, transporting testing equipment and constructing pile mats, etc. would be best priced as method-related charges in Class A.

Carrying out pile tests is measured by number (nr) according to the type of test and the test load under $Q 8^{*}$.

It should be noted that there is no similar rule in Class P: *Piles* to that of Rules M7 and A2 in Class E regarding additional description for piling carried out *below a body of open water*. However, the requirements of Paragraph 5.21 must, nevertheless, be respected, and good practice suggests that including the information referred to in Paragraph 5.21 in any relevant item for piling would help tenderers with the pricing of such items.

This view is confirmed in by the Federation of Piling Specialists (2007), who recommend that the item descriptions for piling and embedded retaining walls should identify work affected by bodies of water and also include relevant information on fluctuations in tide levels.

7.27 Class Q: Piling ancillaries

Changes from CESMM3

- Definition Rule D2 – reference to BS 4449 omitted

Class Q: *Piling ancillaries* accompanies Class P: *Piles* and provides for all the supplementary work associated with piling such as cutting off surplus lengths of piles, supply and fixing of rebar to cast-in-place piles, provision for dealing with obstructions and pile testing, etc.

Risk issue

The work in this Class shall be measured only *where it is expressly required*, and therefore, unless shown on the drawings or expressly or impliedly included in the specification or elsewhere in the contract, the contractor will not be paid for any additional work carried out (Measurement Rule M1 refers).

There is an exception to this in the case of *backfilling empty bore for cast-in-place concrete piles*.

The pile types in this Class mirror those of Class P except that pile diameters are not required in lieu of the Third Division descriptive features, except those for *enlarged bases for bored piles* whose diameter shall be given (Rule A1).

Items for piling ancillaries are *deemed to include disposal of surplus excavated materials* unless otherwise stated (Rule C1 refers).

Where driven piles are to be extended, two items are provided:

- An enumerated item (nr) for preparing the pile to be extended (Q 3 4 *, concrete, or Q 4 4 *, timber).
- A linear metre item for supplying the pile extension (e.g. concrete piles Q 3 5 * <3m or Q 3 6 * >3m).

The enumerated item is ideal for pricing the mobilisation costs associated with extending piles already driven to a provisional set, but driving extended piles is added to the length measurement in Class P by virtue of Measurement Rule M5.

The completion of piles to receive ground beams, pile caps, etc. is measured in two items. Cutting off surplus lengths of piles is measured linearly at Q 1 7 * and Q 3 7 *, and preparing the heads of piles is itemised under Q 1 8 * and Q 3 8 * for concrete piles. Disposal is deemed included in both items as per Coverage Rule C1.

7.28 Class R: Roads and pavings

Changes from CESMM3

- Reference to *DTP specified* replaced with *Manual of Contract Documents for Highway Works*, Volume 1 Specification for Highway Works in Definition Rule D1
- Classification of road building materials changed substantially:
 - R1 *unbound sub-base* items 1–5 in the Second Division;
 - **NB:** *Geotextiles* (R 1 6 *) and *additional depth of stated material* (R 1 7 *) remain from CESMM3
 - R2 *Cement and other hydraulically bound pavements* items 1–8 in the Second Division (A4 also refers)
 - R3 *Bituminous bound pavements* items 1–8 in the Second Division (A5 also refers)
 - R4 *Bituminous bound pavements* items 1–6 in the Second Division including *EME2 base and binder course high performance asphalt* (R 4 2 0), *porous asphalt* (R 4 4 0) and *cold recycled bound material* (R 4 6 0 – A6 also refers)
 - **NB¹:** *Regulating course of stated material* (R 4 8 0) remains from CESMM3
 - **NB²:** solid line across the Third Division excludes depth categories above; this must be an unintended error
 - R 4 8 0 – new item for *cold milling/planing* (misspelt in CESMM4) in the Second Division (C2 also refers)

- R5 *Concrete pavements* substantially changed:
 - Pavement classification changed (Second Division items 1–5)
 - New Rule A7 relating to *wet lean concrete*
 - R 5 6 * reference to BS 4483 deleted (A8 also refers)
 - Revised additional description rule (now numbered A8) is incomplete
 - R 5 6 * *Other fabric reinforcement* deleted from the Second Division
 - R 5 7 * reference to BS 4449 deleted
 - R 5 8 0 wording changed to *separation and waterproof membranes*
- *Joints in concrete pavements*:
 - Two new categories in (1) *transverse joints* and (5) *longitudinal joints*
 - *Butt joints* omitted
- *Kerbs, channels and edgings* now include *footways and paved areas* as well:
 - Classification of kerbs channels and edgings rationalised and reference to BS 7263 omitted (new C5 also refers)
 - *In situ concrete kerbs* and *asphalt channels* omitted
 - First Division *light duty pavements* omitted
 - New Second Division list of pavings and surfacing created (R 7 items 5–8), including *grass concrete paving* and *flexible surfacing* (R 7 6 0)
 - New C5 stating that *kerbs, channels and edgings* are now deemed to include earthworks and concrete ancillaries as well as beds and backings, reinforcement and so on
 - New C6 relating to *precast concrete natural stone block and clay slabs and pavers* and new A13 requires *material, size and thickness* to be stated
 - New C7 relating to *flexible surfacing and in situ concrete surfacing* along with new A14 requiring *materials and thicknesses* to be stated
 - New C8 relating to *grass concrete pavings*
- *Ancillaries* now includes:
 - An item for *raised rib markings* (R 8 2 6)
 - A new A15 relating to *traffic signs and surface markings* requiring *material, size and type to be stated*; type is used instead of reference to *DoT traffic signs, regulations and general directions*
 - C9 amended to refer to M10 not M9

Class R includes roads, runways and other paved areas as well as kerbs, light duty pavements, traffic signs and road markings.

Light duty pavements are no longer accorded their own First Division ‘status’, and such work is now measured under R 7 6 0: *Flexible surfacing*.

Risk issue

Flexible surfacing items are *deemed to include for beds* by virtue of Coverage Rule C7.

Depth categories in the Third Division of Class R are subject to Additional Description Rule A1 which requires that item descriptions shall *state the depth of each course or slab*.

A new Second Division category of *cold milling and planing* has been added at R 4 7 0 which is deemed to include for disposal of arisings (C2) with, presumably, the depth stated in the Third Division (see NB² previously).

Risk issue

There is no requirement to state the location of cold milling/planing despite this being of crucial importance in the contractor’s choice of plant and, therefore, his pricing.

Despite the inclusion of cold planing, it remains a mystery why CESMM4 provides no other road maintenance and repair items, such as the removal and replacement of kerbs and edgings and adjustment of precast concrete slabs.

Risk issue

Kerbs, channels and edgings are deemed to include beds and backings, reinforcement and so on (C4) but are now also deemed to include earthworks and concrete ancillaries by virtue of the new C5.

Under *ancillaries*, both illuminated and non-illuminated *traffic signs* are enumerated and hence require a comprehensive coverage rule (C9) that includes a long list of everything required for such items other than ducts and electrical work. Ducts are measured under Class K: *Ducts*, and electrical work may be given as a Prime Cost Item in Class A.

7.29 Class S: Rail track

Changes from CESMM3

- *Track foundations*:
 - Items for *ballast cleaning*, *tamping* and *pneumatic ballast injection* added to the Second Division along with accompanying Measurement Rules M3, M4 and M5
 - The *provision of ballast to fill voids* is *deemed included* with *ballast cleaning* (new Coverage Rule C1 refers)
- *Taking up*:
 - *Eutectic strip* now included in *sundries* – Third Division (S 2 6 7)
- *Lifting, packing and slewing* now includes *works to existing track*:
 - Second Division items now exclude *turnouts* which have been moved to the Third Division
 - *Buffer stops* moved to the Third Division S 3 * 5
 - *Spot re-sleeping* has been moved from S 6 * 8 to S 3 3 * and renamed *spot replacement of sleepers*
 - New items for *rail turning* (S 3 4 *), *re-railing* (S 3 5 *) and *stressing rail* (S 3 6 *) added
 - New list of Third Division descriptive features and units of measurement
 - First Division unit of measurement (nr) retained in S 3 **, but this seems to be an oversight
 - New Measurement Rules M8 (old D3), M9 and M10
 - New D3 relating to *spot replacement of sleepers*
 - New C3 is old C2
 - C4 and C6 concern *spot replacement of sleepers*; they are slightly different but it looks like the intention to combine them was overlooked in the editing
 - New C5 for *re-railing*
- *Supplying* (S 4 * *):
 - *Steel sleepers* added at S 4 7 3
- *Supplying* (S 5 * *):
 - New Second Division heading *turnouts and crossings* and new Third Division list of descriptive features (including *diamond crossings*) provided along with associated measurement units
 - Second Division measurement unit (nr) retained but looks like an oversight
 - New Second Division item for *prefabricated track panels* and Third Division list of descriptive features (S 5 3 *)
 - New Second Division item for *prefabricated turnouts and crossings* and Third Division list of descriptive features (S 5 4 *)

- New Additional Description Rules A15, A16 (old A10 with reference to *diamond crossings* removed); A18 (old A12) and A19 are virtually the same except for the addition of the word *type* in A19 (looks like an editing issue)
- There are now two First Division items for laying S 6 * * and S 7 * *
- S 6 * * – *Laying with bearers on ballast*:
 - This is the old S 6 * *
 - *Welded joints* is now S 6 * 6 (not S 6 * 7)
 - *Spot re-sleepering* moved to S 3 3 *
 - New M17, D4 and C14 relating to laying rails direct to *concrete slab track*
 - New A20 and A21 (old A13 and A14 slightly amended)
 - New A23 and A25
 - A24 is old A16, but instead of *type and length*, reference is made to *type and weight*
- (S 7 * *) – *Laying*:
 - Sundries moved from CESMM3 S 6 8 * with *static sander* (S 7 5 8) and *eutectic strip* (S 7 5 9) added
 - New Second Division items for *slab track*, *prefabricated track panels*, *prefabricated turnouts*, etc.
 - New accompanying Third Division descriptive features and units of measurement
 - New A24 (old A16 with weight added instead of length)
 - New A25
 - New A26 (old A18)

Class S in CESMM4 introduces significant changes compared to its predecessor CESMM3 reflecting the ‘high-tech’ and highly mechanised rail infrastructure engineering techniques employed worldwide.

The need to measure railway work may arise in a variety of circumstances:

- Laying of new permanent way.
- Replacement of railway lines.
- Quarries and mines.
- Power stations and steelworks.

Rail track work is highly industrialised and mechanised, and there is a variety of track laying methods available, depending upon the length of track required, its access, location and complexity in terms of diamond crossings and turnouts, etc.

Rail track work involves both new track laying and work to existing track.

For new rail track work, materials are often provided by the employer, delivered to site, hence the separation of *supplying* from *laying* for new track work in Class S.

However, the measurement of track foundations is measured on a ‘supply and fix’ basis (S 1 * 0) with ballast measured in m³ but separated into bottom ballast (beneath the sleepers) and top ballast (between the sleepers, but with no deduction of the volume occupied by the sleepers).

In Class S, work to existing track is classified as (a) *taking up* and (b) *lifting, packing and slewing*, the former relating to the removal of track and the latter to the adjustment or realignment of track to be retained. Treatment of existing ballast, such as cleaning and tamping, is also measured, and cleaning is *deemed to include* the provision of ballast to fill voids (Coverage Rule C1 refers).

In some instances, track to be slewed or realigned will require some sleepers to be replaced, and this is provided for in item S 3 3 *, *Spot replacement of sleepers*. The item coverage includes opening out the old sleepers and packing and boxing in the new sleepers with ballast (Rule C3 refers).

The measurement of rail track, both new and existing, is taken along the centre line of the track and includes two rails, but the laying of check, guard and conductor rails is along one rail only.

However, care needs to be taken with turnouts and diamond crossings because:

- The measurement of work to existing track under S 2 * * and S 3 * * excludes turnouts and diamond crossings (Rules M6 and M9 refer).
- The lengths of check, guard and conductor rails under S 2 4 * and S 2 5 * excludes turnouts and diamond crossings (Rule M7 refers).
- The lengths of laying new track is inclusive of the lengths occupied by turnouts and diamond crossings (Rule M14 refers).

The measurement of slab track ('ballastless track') and prefabricated track panels, with timber or concrete sleepers, are measured along the centre line of the track (two rails) including the lengths occupied by turnouts and diamond crossings.

7.30 Class T: Tunnels

Changes from CESMM3

None

Class T: *Tunnels* excludes pipe laying by pipe jacking, thrust boring and the like which is measured under Classes I–L. 'Cut and cover' tunnels are measured under Class E, Class F and other appropriate classes of the method of measurement.

The level of risk in tunnelling operations is recognised in CESMM4, and a considerable burden of financial risk is retained by the employer:

- Both temporary and permanent support shall be measured (Rule M1); this is quite different to other classes where the contractor is deemed to include earthwork support (*supports and stabilisation* is measured under T 8 * *).
- *Supports and stabilisation* also includes a measured item for *forward probing*, whereas the risk of determining prevailing ground conditions lies with the contractor in other classes.
- Work in compressed air shall be so described as an additional description to relevant items (Rule A1 refers).
- Ground freezing, jet grouting, chemical grouting, cement grouting and other soil stabilisation methods are not measured in Class T, or elsewhere, but may be provided for via a provisional sum for defined work in Class A.

Both in situ and preformed tunnel linings are measured under the First Division descriptive features T 2–7, but where complex concrete shapes are required, these *may be* measured under Classes F and G (footnote to CESMM4, page 88, refers).

In situ linings are described in the Second Division as 'sprayed concrete'. This is a generic term for a number of different applications of the process of spraying a mixture of cement and fine aggregate, under pressure, onto a variety of natural and other surfaces in order to carry out structural repairs, fire protection to structural steelwork, tunnel and refractory linings and for lining swimming pools, reservoirs, and a variety of complex-shaped structures such as domes and shells.

The term 'sprayed concrete' is used specifically in Class T which provides two descriptive features in the Second Division – primary and secondary sprayed concrete. This is an implied reference to NATM which relies on an initial thin application of sprayed concrete to the excavated surface followed by a second, thicker, application.

Table 7.36 illustrates a theoretical application of the Work Classification.

Table 7.36 Class T sprayed concrete.

Tunnels					
<u>In situ lining to tunnels</u>					
Sprayed concrete primary; Grade 40; Reinforced					
A	Diameter: 6 - 7 m; 50 mm thick		m ²		
Sprayed concrete secondary; Grade 40; Reinforced					
B	Diameter: 6 - 7 m; 200 mm thick		m ²		

It will be noted that the item descriptions in Table 7.36 include the words ‘primary’ and ‘secondary’, and therefore, it must be assumed that where there is a ‘primary’ lining a ‘secondary’ lining follows by implication.

However, NATM is not the only application of sprayed concrete in tunnel linings, and where a single application is required, or where complex shapes are involved, Classes F and G should be used (the NOTE on page 88 of CESMM4 refers).

Risk issue

The measurement of sprayed concrete in Class T: *Tunnels* is subject to different rules and units of measurement compared to Class F: *In situ concrete* and Class G: *Concrete ancillaries*.

In Class T, the volume for excavation of tunnels is calculated according to a *payment line* shown on the drawings; otherwise, the net dimensions of the excavation are to be used (Rule M2). Payment lines are normally taken to the outside of the tunnel lining, perhaps with a tolerance allowance.

A contractor risk item for overbreak is accommodated by an item of *excavated surfaces* (T 1 7 0 and T 1 8 0) measured in m². This is the area of the payment surface defined by the payment lines on the drawings but, otherwise, is the net area excavated (Rule M4). CESMM4 does not define the word ‘overbreak’.

However, Attewell (1995) makes the point that the term *overbreak* should be restricted to rock as, whilst soils can deform, they cannot fracture or ‘break’. In this sense, the term *over-excavation* would be more appropriate when referring to soil or degraded rock. Attewell (1995) also suggests that any additional excavation beyond the payment line is down to contractor method or preference for an oversized tunnel, perhaps for technical reasons.

Attewell (1995) further explains that the excavation of soil pockets or zones of rock degraded to soil consistency in rock tunnels, beyond the payment line, must be carefully considered in terms of who carries the risk. However, Class T, Measurement Rule M2, stipulates that this would classify as *excavation of other cavities* and, as such, would be measurable under T 1 5 *

(for rock) and T 1 6 * (for other stated material) in m³, with the diameter stated in accordance with the Third Division.

Filling within tunnels, including *other cavities*, is included in Class E: *Excavation* (see Class T heading of exclusions). However, there are no specific items in Class E relating to tunnelling or in Class F: *In situ concrete* for filling.

Coverage Rule C1 establishes that *excavated surfaces* items, along with other excavation items, are deemed to include off-site disposal and removal of dead services.

7.31 Class U: Brickwork, blockwork and masonry

Changes from CESMM3

- Unit of measurement for walls exceeding 1 m thick changed to m² (was m³)
- This may not be intentional as Measurement Rule M2 still refers to *volumes*

Measurement Rule M1 requires that *each skin* of cavity construction *shall be measured*, and hence, cavity walls are not regarded as ‘composite’. Additional Description Rule A4 requires *cavity or composite construction* to be stated in the item description for walls, facing to concrete, casings and so on, and Rule A5 provides that wall thickness shall be given.

Rule M3 requires that *mean dimensions* shall be used to calculate areas and volumes in this class of work, including the heights of *columns* and *piers*, and surface features, such as band courses and corbels, shall be measured by their mean length (Rule M4 refers). *Inter alia*, this implies that centre lines of brickwork, blockwork and masonry shall be used for quantity take-off.

The area for *fixings and ties* to cavity work and the like shall be given under U * 8 6, but the area measured shall be *the smaller of the two areas measured* for cavity brickwork, masonry, etc., that is, not the centre line of the wall.

7.32 Class V: Painting

Changes from CESMM3

- Reference to lead in V 1 * * omitted

Painting is straightforwardly measured as the area covered, with no deductions for holes or openings <5 m². Narrow widths are measured in linear metres.

Less easy to interpret is the phrase *isolated groups of surfaces*, which is used in several places in Class V.

Measurement Rule M3 states that items for *isolated groups of surfaces* arise when surfaces of different shapes or dimensions are measured separately if they satisfy the Definition Rule D1 test that each group does not exceed 6 m² in total. Additional Description Rule A3 requires the work and its location to be stated in the item description.

The point of this provision is to provide the tenderer with a count (nr) of small areas of work whose location falls outside the main body of work and therefore has a different cost implication. *Isolated groups of surfaces* of different materials are separately measured.

Notwithstanding the foregoing, the footnote to CESMM4, page 94, states that painting to areas having **the same** shape and dimensions may be measured by number as *isolated groups of surfaces* instead of by area or length (narrow widths).

Risk issue

As there is no definition rule to this footnote, nor any reference to other definition rules, such isolated areas could well be substantial.

It would, therefore, be incumbent on the tenderer to establish such areas from the drawings in order to determine their quantities for pricing purposes.

7.33 Class W: Waterproofing**Changes from CESMM3**

- W 6 ** – *Sheet linings membrane* added

Waterproofing, protective layers and sheet membranes, etc. are straightforwardly measured as the area covered, with no deductions for holes or openings <5 m². Narrow widths are measured in linear metres.

Less easy to interpret is the phrase *isolated groups of surfaces*, which is used in several places in Class W.

Measurement Rule M4 states that items for *isolated groups of surfaces* arise when surfaces of **different** shapes or dimensions are measured separately if they satisfy the Definition Rule D2 test that each group does not exceed 6 m² in total. Additional Description Rule A2 requires the work and its location to be stated in the item description.

The point of this provision is to provide the tenderer with a count (nr) of small areas of work whose location falls outside the main body of work and therefore has a different cost implication. *Isolated groups of surfaces* of different materials are separately measured.

Notwithstanding the foregoing, the footnote to CESMM4, page 96, states that waterproofing to areas having **the same** shape and dimensions may be measured by number as *isolated groups of surfaces* instead of by area or length (narrow widths).

Risk issue

As there is no definition rule to this footnote, nor any reference to other definition rules, such isolated areas could well be substantial.

It would, therefore, be incumbent on the tenderer to establish such areas from the drawings in order to determine their quantities for pricing purposes.

7.34 Class X: Miscellaneous work**Changes from CESMM3**

- X 1 8 * *Fences – Road restraint system* replaces *metal crash barriers*
- *Gates and stiles* – Second Division rationalised
- Drainage to structures above ground – *Asbestos cement* deleted from the Second Division
- A 5 0 0 – *Open cell block systems* added; measured by (nr) with details to be given as per new A7 (*open cell block systems* are not listed in the Class X heading)

Items for *fences*, which includes *road restraint systems*, shall be deemed to include excavation, disposal, backfilling, concrete, formwork and reinforcement, etc. (Rule C1) as well as posts (Rule C2). Details of the type of fence and its foundations shall be given as additional description (Rule A2).

The distinction between *box* and *mattress* gabions is made in Rule D4 according to whether they exceed 300 mm or not. Rule D4 also deems that filling shall be imported unless otherwise stated.

7.34.1 Open cell block systems

It is surprising that Class X 5 0 0 – *Open cell block systems* – does not provide a definition of what is meant by the term. Open cell blocks are commonly used in a wide variety of applications, such as grassed parking areas, revetments, retaining walls and so on, and all sorts of different shapes, sizes and configurations are available.

There is no clear guidance, however, and a most unsatisfactory unit of measurement, for the billing of such items. It would have been most helpful had there been a list of Second and Third Division features and units of measurement.

Therefore, the bill compiler is left with the dilemma of choosing whether to measure open cell blocks as:

- a) Precast concrete under H 6 0 0: *Segmental units* or
- b) Under X 5 0 0: *Open cell block systems*.

Both are enumerated (nr) but:

- a) There are no measurement rules for segmental units in Class H although the bill compiler is helped by Additional Description Rules A1 and A2.
- b) Additional Description Rule A7 of Class X requires the descriptive features of such work to be stated.
- c) In neither case is there provision to describe open cell block systems adequately.

Risk issue

There is no suitable method of measurement for a substantial gravity retaining wall within CESMM4.

7.35 Class Y: Sewer and water main renovation and ancillary works

Changes from CESMM3

- None

Thanks to ‘no-dig’ or trenchless technology, a great deal of sewer renovation can be carried out without the disruptive effect of open excavation.

Where excavation is *expressly required*, Coverage Rule C1 deems that relevant Class Y items are *deemed to include* earthwork support, backfilling, removal of dead services, etc., and item descriptions are to state the depth of excavation in 1 m stages pursuant to Additional Description

Rule A4. Crossings, reinstatements and extras to excavation and backfilling, etc. are to be measured according to Classes K and L (Rule M2 refers).

Where manual or remotely controlled methods are *expressly required*, this shall be stated in item descriptions (Rule A3 refers).

Additional description given for Class Y work shall include provision of sewer dimensions and profiles (Rule A2).

7.36 Class Z: Simple building works incidental to civil engineering works

Changes from CESMM3

- D8 – *taps* are classed as *pipe fittings*
- A23 and A27 – reference to British Standards omitted
- A30 and A31 – reference to British Standards omitted

Class Z is more comprehensive than it would appear, because building work such as in situ concrete, drainage, ducts, brickwork, etc. would be covered by the relevant Class in other parts of the method of measurement, as noted in the heading on page 105 of CESMM4.

Some types of building work may be ‘hidden away’ in certain cases, such as *drainage to structures above ground* in Class X: *Miscellaneous work*, which provides itemisation for guttering, downpipes, fittings, etc. (X 2 * *).

Due to the detailed nature of building work, it is likely that there will be a considerable degree of additional description required in Class Z and items should be coded with an appropriate suffix where required.

When measuring suspended ceilings, bill compilers familiar with SMM7 should note that both primary support systems and edge trims are deemed included in Z 4 5 * (Coverage Rule C6 refers).

Notes

1. *The headings in this Chapter generally follow those of CESMM4.*
2. Now published by the Civil Engineering Contractors Association (CECA).
3. http://www.vibroflotation.com/Vibro/vibroflotation_fr.nsf/site/Vibro-Compaction.Effects-and-Test (accessed 7 April 2015) and https://www.youtube.com/watch?v=_v10uOev78U (accessed 7 April 2015).
4. <https://www.gov.uk/japanese-knotweed-giant-hogweed-and-other-invasive-plants> (accessed April 7, 2015).5.

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