



**PROGRAM** : B. Tech  
*CIVIL ENGINEERING*

**SUBJECT** : **Contract Management**

**CODE** : **CMC411**

**DATE** : SUPPLEMENTARY EXAMINATION 2013  
14 JULY 2014

**DURATION** : (SESSION 2) 11:00 - 15:00

**WEIGHT** : 40 (Year Mark): 60 (Exam.)

**TOTAL MARKS** : 100

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**ASSESSOR** : Tobie Louw

**MODERATOR** : Lourens de Koning

**NUMBER OF PAGES** : 9 PAGES AND 15 ANNEXURES

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**INSTRUCTIONS** : ONLY ONE POCKET CALCULATOR PER CANDIDATE  
MAY BE USED.

**REQUIREMENTS** : For the O & O questions students may use the applicable  
sheets attached.

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**INSTRUCTIONS TO STUDENTS**

Note the following:

- This is an open book examination.
- Students are not allowed to use mobile phones for any purpose whatsoever.
- Make use of bullet or a numbering format where appropriate.
- If and where appropriate, make use of sketches or diagrams to illustrate your answers
- In a number of questions, students are required to apply their minds on how to handle the specific situation and it should be noted that points will and should be given for various aspects, not necessarily in terms of a strict pre-determined memorandum only. Innovative answers will be rewarded as well as valid answers that are deemed reasonable
- Keep answers as condensed /short as possible.
- Please answer only 4 of the 4 questions.

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**QUESTION 1 (On next page)**

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## CMC411 CONSTRUCTION MANAGEMENT IV

**EXAMINATION – 2014: Supplementary.**

**Duration 4 hours**

### **Question 1 - Unit Rates- Crushing Plant**

The requirement is to compile a unit rate (R/m<sup>3</sup>) for the provision of crushed stone on a project. Only the >10mm < 20mm Concrete Stone and Crusher-Run is required, all other material will be wasted. Allow for a 10% Company Margin in your final answer.

1. Do not allow for VAT in your final answer.
2. All prices of items hired or purchased are inclusive of VAT. (Do correction for calculation)
3. You have to hire the Crushing Plant from your Company for R 3420 -00 per month or part thereof.
4. You will purchase 5 sets of conveyor belt at R 5130-00 per m,
5. The length of each belt will be 8 m long.
6. These conveyor belts will feed :
  - i) The crusher
  - ii) From the Crusher to the Screens
  - iii) From the Screens:
    - A belt each, to the 2 final product stockpiles
    - A belt to the waste stockpile.
7. The Conveyor Belts will be sold back to the Plant Manager at 50% of the purchase price
8. The cost of small equipment and hand tools will be R 4140-00 for the production period, and will be written off over this period.
9. Each component will use the following electric motors with demands as follows:
  - iv) The crusher 60 kW
  - v) The Screens 15 kW
  - vi) The Conveyor belts 5 kW each.
10. The cost of electricity and water for production purposes only, will be as follows:
  - i) Connecting fee for electricity is R2400-00 and disconnect R 2000-00
  - ii) The unit rate will R 1 – 50 per kWh
  - iii) Water will be R 2500 per month or part thereof, irrespective of volume consumed.
  - iv) Connecting fee for water is R800-00 and to disconnect will be R 600-00
11. The prices to connect and disconnect electricity and water must be included in the cost per ton of product supplied.
12. The total production team will consist of:
  - i) 1 Supervisor @ R 60.00 / hour
  - ii) 12 Helpers @ R 20.00 / hour
  - iii) 4 Plant Operators @ R 40.00 / hour
13. The total erection and dismantling team will consist of:
  - a) 1 Construction Supervisor @ R 55.00 / hour
  - b) 8 Helpers @ R 19.00 / hour
  - c) 2 Carpenters @ R 35.00 / hour
14. The proposed production hours will be from 07h00 until 18h00 each day for 5 days per week
  - i) An unpaid 1 (one) hour lunch break was negotiated with the production team.
  - ii) The Erection and Dismantling teams will work the same hours
  - iii) Overtime (OT) rate will be 50% more than the normal time (NT) rate, for all activities on site.
  - iv) Maximum hours per week for NT will be 45 hours per week
15. The Production Rate of the Crushing plant will be 300 t / shift

### CMC411 CONSTRUCTION MANAGEMENT IV

16. The total tonnage for both the products required is 90 000 ton.
17. You intend to utilize the Crushing and Screening plant which belongs to the Company
18. You intend to recommend that your Company recovers the costs of erecting, running, and removing the Crushing and Screening Plant over the duration of the contract as a R per m<sup>3</sup> rate
19. The Truck with mounted crane will be required for total Erection and Dismantle period.

You are required to:

Calculate the R/m<sup>3</sup> (Including Margin and Excluding VAT) for the costs of:

- i) erection,
- ii) running,
- iii) dismantling of the Crushing and Screening plant.

A) The required quantities of product as per the BOQ of the Contract:

No.	Strength	Unit	Quantity	Unit
1	Crusher Run	< 10 mm	65000	Ton
2	Concrete stone	>10mm < 20mm	25000	Ton
3	Rock for crushing	No charge ( Client will supply)		
4	Loading of Belts	No charge ( Client will supply)		
5	Wastage	10 % over the Production Volume		Ton
6	Wastage	Relative Density 2000 kg / m <sup>3</sup>		

B) Mechanical Information from the Plant Manager:

Transport costs of Crushing and Screening plant to site	R 8 500 -00	Excluding VAT
Transport costs of Crushing and Screening plant back to yard	R 9 500 – 00	Excluding VAT
Erection costs and initial service	R 20 000 – 00	Excluding VAT
Dismantling costs and packing service	R 15 500 - 00	Excluding VAT
Hire and service cost per month or per thereof.	R 3 000 – 00	Excluding VAT

C) Civil Engineering Cost for Erection and Dismantling:

A	Description Period	Unit	Quant.	Price	Remarks
1	Const. period - Erection	Days	12		
2	Const. period - Dismantle	Days	6		
B	Material cost per Unit				
1	Materials - Formwork	m <sup>2</sup>	1	140	Including Vat
2	Materials - Concrete	m <sup>3</sup>	1	850	Including VAT
3	Materials - Reinforcing	Ton	1	2850	Including VAT
C	Material required				
1	Materials - Formwork	m <sup>2</sup>	45		
2	Materials - Concrete	m <sup>3</sup>	175		
3	Materials-Reinforcing St	Each m <sup>3</sup> of Concrete requires 130 kg of Reinforcing.			
4	Materials - Consumables	Total Period	1	1700	"Once of" for Erection only (Inc. VAT)
D	Equipment Cost per Unit				
1	Equip. – Special Truck with Crane - Erection	Days	1	2000	Including VAT
2	Equip. – Special Truck with Crane - Dismantling	Days	1	2000	Including VAT

## CMC411 CONSTRUCTION MANAGEMENT IV

### D) Production information & Mixing Costs During Construction:

Allow for overtime of "Time and a Half" on production team

Allow for wastage on Crushing and Screening plant

10 %

Allow the removal of concrete foundations from site for:

R 50 – 00 / m<sup>3</sup>

i) Production waste

ii) Foundation removal at end of Contract.

The Student must provide the following:

- a) Total price to Build (Erect) the crushing plant
- b) The production period
- c) Total price to Build (Erect) the crushing plant
- d) Total price to Break Down (Demolish) the crushing plant
- e) Price per m<sup>3</sup> of product

Total Marks (25)

### Question 2 Owning and Operating cost.

A plant Hire Company see the need to enhance the machine fleet of the Company with a Grader

1. This machine will be used on various contracts in a mining operation.
2. These operations will be 6 days per week (No Sunday work)
3. These operations continue throughout the year with no time breaks ( Do not bring PPH in the calculation)
4. The machine will be utilized as follows:
  - i) Working time
  - ii) Service time as per the "Preventative Maintenance" program.
  - iii) Standing 12 % of time (Breakdown / Unscheduled Maintenance)
5. General information on the Grader is listed below in table format.
6. The payback period of the Grader will be 5 (five) years. (Write the machine off over this period)
7. The applicable interest rate will be 11 % pa. See tables provided
8. The hours of the Grader have been estimated at 8.5 hours per day. (daylight hours) (Client rules).
9. The service and breakdown times need to be attended to during "daylight hours". (Client rules).
10. Insurance will be 5% of the Purchase price (Including Tyres) per year.
11. The anticipated economical lifetime of the machine is estimated at 13000 h
12. The residual value of the machine after 5 (five) years will be 25 %
13. The fuel price is R 14.20 per liter
14. The operator:
  - i) Rate for normal time (NT) is R 30.00 per hour. Rate for over time (OT) is R 40.00 per hour
  - ii) Max. normal hours per week 45 (Basic Conditions of Employment Act)
  - iii) Max. allowable overtime (OT) per week is 10 hours per week. (Basic Conditions of Employment Act)
  - iv) The operator agreed to a 30(thirty) minutes lunch break with no pay for lunch.
  - v) The lunch break will not count as "working hours".
  - vi) The 9.0 hours working including the 0.5 hour lunch, represent a working day.
  - vii) The operator must receive annual leave (at full pay) at an allocation of 15 working days.
  - viii) During the leave period:
    - a) A standby operator must be hired in at a rate 15% more than the normal operator.
    - b) The normal operator will not receive overtime (OT)
15. Ignore any VAT aspect in the calculations.

#### CMC411 CONSTRUCTION MANAGEMENT IV

##### 16. During machine stoppages (Service of breakdowns):

- i) The operator will receive normal remuneration.
- ii) The Grader will not be replaced, but no income will be earned from the client for those days. (NOTE: Leave this calculation to the very end)

Note: All prices in this Table R x 1000

Item	Make	Model	Price	Unscheduled Maintenance	Major Components Replace Labour included			Tyres (6)		
					Lifespan	Duration to repair	Freq - h	Engine	Price each	Freq hours
Grader	Cat	140 H	R2 900	30 % of price (Including Tyres). Tyres)	4 Days	10000	R 800	R 20	4000	2 days

Major Components Replacement Labour included			Preventative Maintenance Labour included			GET Labour included			Fuel Con
Duration to Repair	Freq - h	Final Drive	Price	Freq - h	Duration to repair	Price	Freq - h	Duration to change	l/h
3 Days	7500	R600	R 9	500	1 Day	R 8	2000	1 Day	25

Note: Do not escalate the values in these tables, assume these are applicable for total period

It is required from the Student to Calculate the hourly cost for:

- i) Owning the machine
- ii) Operating the Machine without the operator
- iii) The operator

Total Marks (25)

### QUESTION 3 – CONTRACTS GENERAL

- 3.1 Name the four standard "General Conditions of Contract" mostly used in South Africa? (2)
- 3.2 Which key issues need to be addressed by the conditions of a contract? (1)

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- 3.3** A project plan needs to be developed before compiling a project.  
This plan usually consists of ten aspects. Name eight of these aspects. (2)
- 3.4** Name the three main types of contracts which are based on the payment method. (3)
- 3.5** Name the four aspects influencing the promoter's choice of the type of contract. (2)
- 3.6** Name four types of documents needed during the tender award phase. (2)
- 3.7** Name the two types of specification in a contract. (1)
- 3.8** Describe in your own words the effect of a promoter trying to shorten the construction phase. (1)
- 3.9** Describe the meaning of a qualified tender submission. (1)
- 3.10** Name the main points to be covered during a "kick-off" meeting. (3)
- 3.11** When does the responsibility and liability of the site change to the contractor? (1)
- 3.12** Name the most important aspect to be controlled at the commencement of a contract. (1)
- 3.13** Discuss issues to be addressed in a variation order. (2)
- 3.14** Name a few reasons why a main contractor appoints sub-contractors. (1)
- 3.15** Describe the difference between a nominated sub-contractor and a non-nominated sub-contractor. (1)
- 3.16** Describe the process if the main contractor is in doubt about the abilities of a nominated sub-contractor. (1)

Total Marks [25]

### QUESTION 4: Earthworks Machines

#### A) General information

You are responsible for pricing a tender to build an earth fill embankment.

You anticipate to hire plant for the whole operation

Do not allow for any profit or OHC (Overhead costs)

The anticipated contract period will be as per the requirements of the project (Building of the embankment)

Because of site constraints, machine working hours per month will be limited to 208 h/m.

Assume no holiday breaks, and no compensation for Public Holidays.

Price of Diesel is R 13-90 per liter.

The Haul distance is 5.0 km from borrow pit to embankment. (Centre to Centre)

The dimensions of the embankment are as per the sketch below.

Use the Tables below and assume the following:

- Only (1) one water Truck, (1) one Roller and (1) one Grader will be adequate to keep up with the watering operation and the watering / grading of the haul road as well as the watering / spreading / compacting of the embankment.
- The Excavator for loading, as per the table below, and as per the additional information from suppliers. Use only 1 (one) Excavator

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- c) The Haulers for moving the material, as per the table below, and as per the additional information from suppliers.  
d) The number of haulers needs to be determined. These haulers are freely available at various "Hire Companies" in the area, all at the same price.

The density of the material in the bank will be (98 % Mod AASTHO) and take it as 100%

The "In Situ" density of the material is at 80 % Mod AASTHO and this will be 1850 kg / m<sup>3</sup>

The "Loose" density of the material is at 65 % Mod AASTHO.

The "Bulking Factor" between the material loose in the Trucks and compacted in the bank is 1.3

Assume the information in C (**Labour / Operator information**) below, for the requirements of the Personnel.

The number of ADT (Truck Operators) need to be calculated. (Same as the number of trucks)

Do NOT provide for additional persons for Sick leave, Normal leave. Work only on the required hours

Working on site will be an 8.0 hours / day at 6 days per week.

A Lunch break of 1 (one) hour is not included in the 8.0 (eight) hours and this break will not be paid for.

If working is more than 45 hours per week OT (Overtime) must be paid at 1.5 time normal rate.

The total length of the wall is 2200 m. (Assume the cross section of the wall is constant over the total length of the wall).

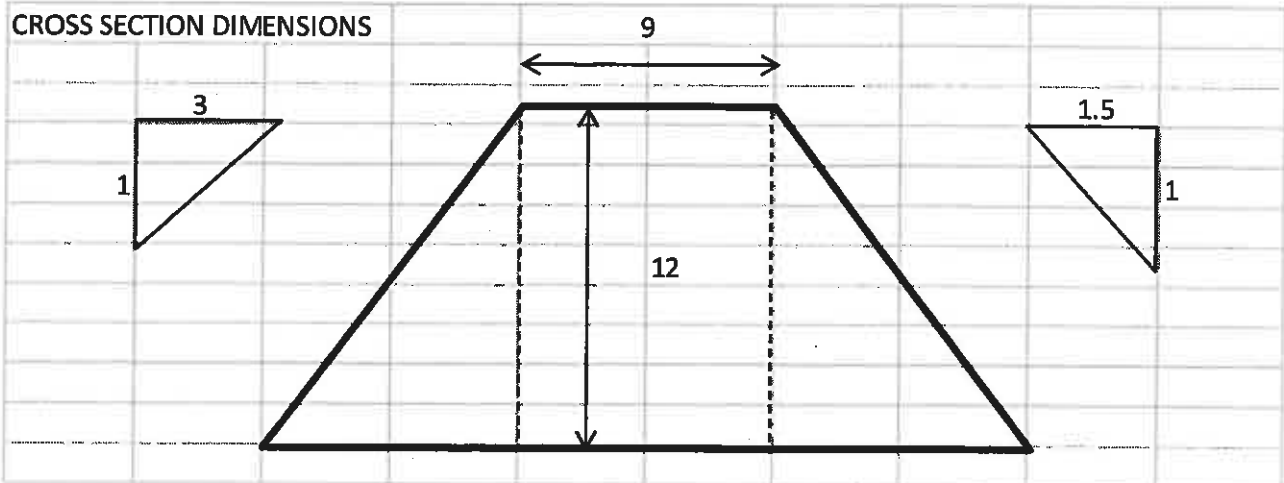
Because of the borrow pit layout the swing angle of the Excavator will be 180 Deg.

The Digging Depth of the Excavator will be 50% of maximum.

Condition of soil is Medium to Easy Collapsed soil.

Work efficiency is: Good.

Bin Capacity of the Hauler, as per the SAE 2:1 Specification. (Without automatic gate)



#### A) Equipment information

No.	Machine (Operator Class)	Make	Model	Machine Price		Tires			Machine Life in hours
				Buy X 1000	Dry Rent / HOUR All inclusive	Price Each	Freq in hour	No. off	
1	Dozer (A)	Komatsu	D 85 EX	R 3 400	R 980	xxx	xxx	None	12 000
2	Grader (B)	Caterpillar	140 H	R 2 600	R 600	R 18 000	2500	6	14 000
3	Exca. (B)	Hitachi	ZX 270	R 1 900	R 420	xxx	xxx	None	10 000
4	Roller (A)	Bomag	Drum	R 1 100	R 360	R 22 000	5000	2	16 000
5	ADT (A)	BELL	B 25 D	R 1 200	R 480	R 25 000	3000	6	15 000



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6	Water (A) Truck	Ford	B 200	R 800	R 300	R 6 000	5000	10	30000
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Equipment information (Continue)

No.	Machine	Resid- ual Value	Oil and lub.	Under carriage / Tracks			GET			Fuel Consump- tion
		%	%	Price	Freq. in hours	%	Price / set	Freq. in hours	%	Liters / hour
1	Dozer	20	6	400 000	8000	6	15 000	1500	3	30
2	Grader	---	6	---	---	---	20 000	2000	3	24
3	Excavator	15	6	300 000	6000	5	7 000	1500	3	28
4	Roller	---	5	---	---	---	---	---	---	17
5	ADT (Truck)	---	5	---	---	---	---	---	---	22
6	Water Truck	---	3	---	---	---	---	---	---	15

B) Labour / Operator information

	Description	Unit	Quant. /Number	Cost R / h	Remarks
1	Construction - Foreman	Hour	1	32	All in Rate per hour
2	Construction - Supervisor	Hour	1	28	All in Rate per hour
3	Construction - Labour / Telly	Hour	3	18	All in Rate per hour
	Technician	Hour	1	45	All in Rate per hour
	Technician - Assistant	Hour	2	25	All in Rate per hour
4	Operator Class A	Hour	Calculate	35	All in Rate per hour
	Operator Class B	Hour	1	45	All in Rate per hour

C) Information provided

- All Information in Data Tables above, does not necessarily all apply to this question.
- Information provided by the manufacturers, these figures are example purposes only and does not indicate any preference.

D) Required of the Students;

- Determine the number of ADT's (Trucks) required, to balance with the Excavator (15)
- Determine the duration of this operation. In working days (10)

Total Marks [25]

**No Residual**

	Price of item
8	-R 1 000 000
36	-R 1 200 000
42	-R 1 400 000
48	-R 1 600 000
54	-R 1 800 000
60	-R 2 000 000
	-R 2 200 000
	-R 2 400 000
	-R 2 600 000
	-R 2 800 000
	-R 3 000 000
	-R 3 200 000
	-R 3 400 000
	-R 3 600 000

[illegible]

36	R 33 214	R 39 857	R 46 500	R 53 143	R 59 786	R 66 429	R 73 071	R 79 714	R 86 357	R 93 000	R 99 643	R 106 286	R 112 929	R 119 572
42	R 29 276	R 35 131	R 40 986	R 46 841	R 52 696	R 58 551	R 64 406	R 70 262	R 76 117	R 81 972	R 87 827	R 93 682	R 99 537	R 105 392
48	R 26 334	R 31 601	R 36 867	R 42 134	R 47 401	R 52 668	R 57 934	R 63 201	R 68 468	R 73 735	R 79 002	R 84 268	R 89 535	R 94 802
54	R 24 057	R 28 868	R 33 679	R 38 491	R 43 302	R 48 113	R 52 924	R 57 736	R 62 547	R 67 358	R 72 170	R 76 981	R 81 792	R 86 604
60	R 22 244	R 26 693	R 31 142	R 35 591	R 40 040	R 44 489	R 48 938	R 53 387	R 57 836	R 62 284	R 66 733	R 71 182	R 75 631	R 80 080
12	-R 1 000 000	-R 1 200 000	-R 1 400 000	-R 1 600 000	-R 1 800 000	-R 2 000 000	-R 2 200 000	-R 2 400 000	-R 2 600 000	-R 2 800 000	-R 3 000 000	-R 3 200 000	-R 3 400 000	-R 3 600 000

Tables for Payback														
20	% Residual	Values												
Interest														
10	-R 1 000 000	-R 1 200 000	-R 1 400 000	-R 1 600 000	-R 1 800 000	-R 2 000 000	-R 2 200 000	-R 2 400 000	-R 2 600 000	-R 2 800 000	-R 3 000 000	-R 3 200 000	-R 3 400 000	-R 3 600 000
36	R 27 480	R 32 976	R 38 473	R 43 969	R 49 465	R 54 961	R 60 457	R 65 953	R 71 449	R 76 945	R 82 441	R 87 937	R 93 433	R 98 929
42	R 24 320	R 29 184	R 34 048	R 38 912	R 43 776	R 48 640	R 53 504	R 58 368	R 63 232	R 68 096	R 72 960	R 77 824	R 82 688	R 87 552
48	R 21 957	R 26 348	R 30 739	R 35 131	R 39 522	R 43 913	R 48 305	R 52 696	R 57 088	R 61 479	R 65 870	R 70 262	R 74 653	R 79 044
54	R 20 125	R 24 150	R 28 174	R 32 199	R 36 224	R 40 249	R 44 274	R 48 299	R 52 324	R 56 349	R 60 374	R 64 399	R 68 424	R 72 449
60	R 18 664	R 22 397	R 26 130	R 29 863	R 33 596	R 37 329	R 41 061	R 44 794	R 48 527	R 52 260	R 55 993	R 59 726	R 63 459	R 67 191
20	% Residual	Values												
Interest														
12	-R 1 000 000	-R 1 200 000	-R 1 400 000	-R 1 600 000	-R 1 800 000	-R 2 000 000	-R 2 200 000	-R 2 400 000	-R 2 600 000	-R 2 800 000	-R 3 000 000	-R 3 200 000	-R 3 400 000	-R 3 600 000
36	R 28 571	R 34 286	R 40 000	R 45 714	R 51 429	R 57 143	R 62 857	R 68 571	R 74 286	R 80 000	R 85 714	R 91 429	R 97 143	R 102 857
42	R 25 421	R 30 505	R 35 589	R 40 673	R 45 757	R 50 841	R 55 925	R 61 009	R 66 093	R 71 177	R 76 262	R 81 346	R 86 430	R 91 514
48	R 23 067	R 27 680	R 32 294	R 36 907	R 41 521	R 46 134	R 50 748	R 55 361	R 59 974	R 64 588	R 69 201	R 73 815	R 78 428	R 83 041
54	R 21 245	R 25 494	R 29 743	R 33 992	R 38 241	R 42 491	R 46 740	R 50 989	R 55 238	R 59 487	R 63 736	R 67 985	R 72 234	R 76 483
60	R 19 796	R 23 755	R 27 714	R 31 673	R 35 632	R 39 591	R 43 550	R 47 509	R 51 468	R 55 428	R 59 387	R 63 346	R 67 305	R 71 264
25	% Residual	Values												
Interest														
12	-R 1 000 000	-R 1 200 000	-R 1 400 000	-R 1 600 000	-R 1 800 000	-R 2 000 000	-R 2 200 000	-R 2 400 000	-R 2 600 000	-R 2 800 000	-R 3 000 000	-R 3 200 000	-R 3 400 000	-R 3 600 000
36	R 27 411	R 32 893	R 38 375	R 43 857	R 49 339	R 54 821	R 60 304	R 65 786	R 71 268	R 76 750	R 82 232	R 87 714	R 93 196	R 98 679
42	R 24 457	R 29 348	R 34 239	R 39 131	R 44 022	R 48 913	R 53 805	R 58 696	R 63 587	R 68 479	R 73 370	R 78 262	R 83 153	R 88 044
48	R 22 250	R 26 700	R 31 151	R 35 601	R 40 051	R 44 501	R 48 951	R 53 401	R 57 851	R 62 301	R 66 751	R 71 201	R 75 651	R 80 101
54	R 20 542	R 24 651	R 28 759	R 32 868	R 36 976	R 41 085	R 45 193	R 49 302	R 53 410	R 57 519	R 61 627	R 65 736	R 69 844	R 73 953
60	R 19 183	R 23 020	R 26 857	R 30 693	R 34 530	R 38 367	R 42 203	R 46 040	R 49 877	R 53 713	R 57 550	R 61 387	R 65 223	R 69 060



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Strong Reliable Machines Strong Reliable Support

## Products

### Articulated Dump Truck

#### B25D

- Proven performance
- Low operating costs
- Standard on board weighing
- Integral safety features

#### Key features:

- Gross Power: 206 kW
  - Gross Torque: 1 120 Nm
  - Rated Payload: 23 200 kg
- Option Weights

Bin liner:	1,053 kg
Tailgate:	651 kg
Extra wheelset:	538 kg

#### Operating Masses

	Unladen	Laden
Front:	9,620 kg	12,860 kg
Middle:	4,420 kg	14,400 kg
Rear:	4,360 kg	14,240 kg
Total:	18,400 kg	41,500 kg

#### Ground Pressure

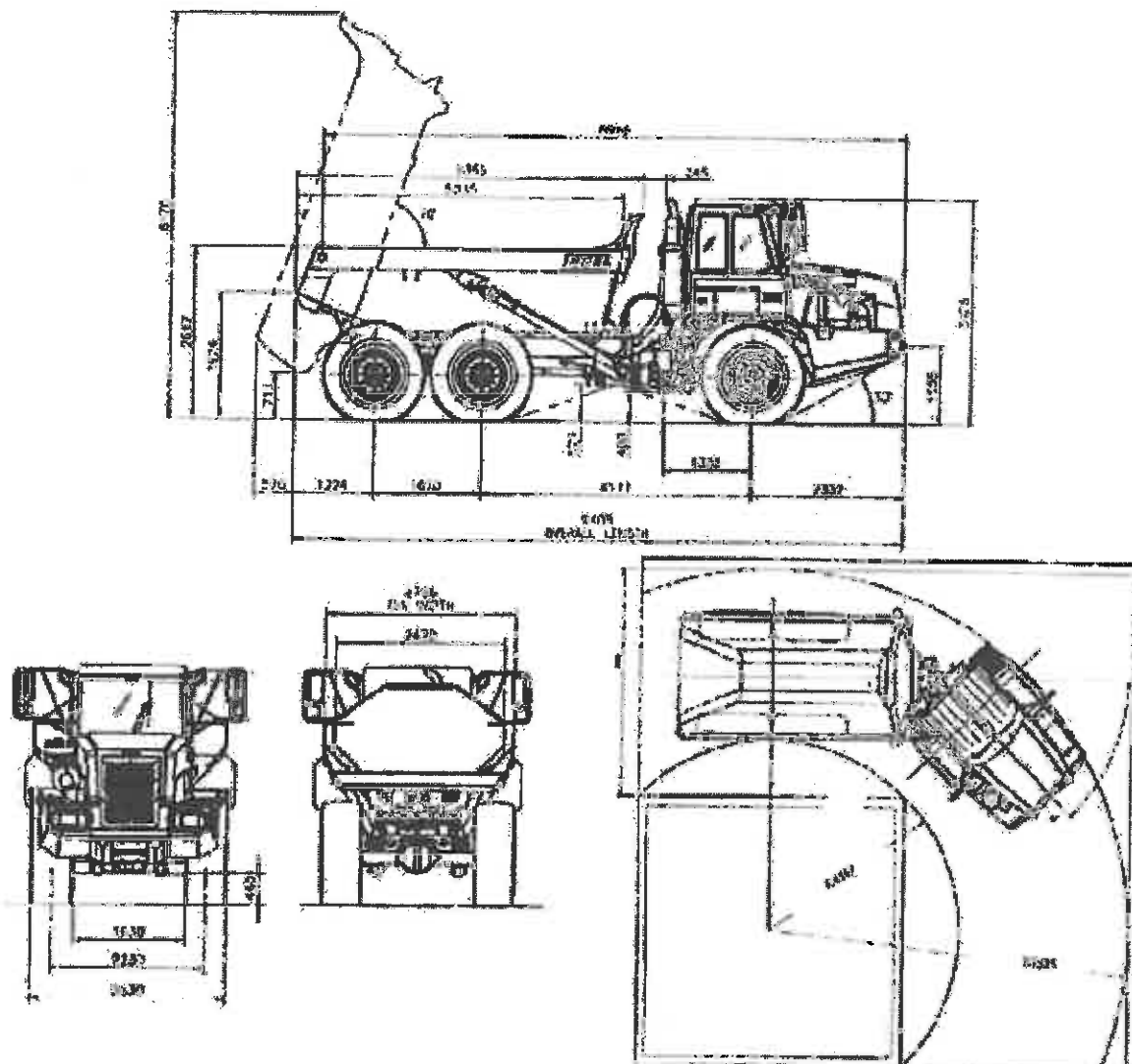
	Laden (no sinkage)	Laden (with sinkage)
Method of Calculation:		
23.5 R25		
Front:	248 kPa	133 kPa
Middle:	237 kPa	146 kPa
Rear:	287 kPa	148 kPa

#### Cab

ROPS/FOPS certified

71 dBA internal sound level measured according to ISO 6396

#### Line Drawings



### Vehicle Speeds

1st:	8 km/h (5 mph)
2nd:	13 km/h (8 mph)
3rd:	22 km/h (14 mph)
4th:	31 km/h (19 mph)
5th:	44 km/h (28 mph)
6th:	53 km/h (33 mph)
R:	8 km/h (5 mph)

### Transfer Box

Remote mounted

Manufacturer: Bell

Model: 13100

Layout: Three in-line helical gears

**Output Differential:** 67/33 torque proportioning, Pneumatically lockable on the move.

#### Axles

High strength steel fabricated with spiral bevel type gears on the limited slip locking differential and heavy duty outboard planetary gears.

**Model:** Bel 15T

#### Braking System

<b>Service Brake:</b>	Dual circuit, full hydraulic actuation caliper brakes on all wheels
<b>Maximum brake force:</b>	164 kN (36 900 lbf)
<b>Park &amp; Emergency:</b>	Spring applied, air released driveline mounted disc
<b>Maximum brake force:</b>	308 kN (69 000 lbf)
<b>Auxiliary Brake:</b>	Automatic exhaust brake and Engine Valve Brake (EVB) Variable Adjustable Hydraulic Retarder in transmission
<b>Maximum retardation:</b>	442 kW (593 hp)

#### Wheels

**Earthmover**

**Tyre:** 23.5R25

#### Suspension System

<b>Front Type:</b>	Semi-independent quad rubber mounted leading arm linkages supported by nitrogen and oil filled struts
<b>Rear Type:</b>	Pivoting working beams, distributing equal load through laminated rubber suspended in blocks. Each axle is coupled to the chassis by four rubber-bushed links for ideal vertical movement.

#### Hydraulic System

Variable displacement with load sensing system incorporating a ground driven emergency steering pump.

<b>Flow:</b>	184 l/min (48.6 gal/min)
<b>Pressure:</b>	25 Mpa (3,675 psi)
<b>Filter:</b>	5 microns

#### Steering System

Hydraulically actuated, low effort, fast acting. Two double-acting steering cylinders

Lock to lock turns: 4.1

Steering Angle: 45°

### Dumping System

Two double-acting, single stage, dump cylinders

Raise Time: 12 s

Lowering Time: 6 s

Tipping Angle: 70°

### Pneumatic System

Air drier with heater and integral unloader valve, serving park brake and auxiliary functions

System Pressure: 810 kPa (117 psi)

### Electrical System

Voltage: 24 V

Battery Type: Two maintenance free permanently sealed

Battery Capacity: 2 X 105 Ah

Alternator Rating: 28 V 80 A

### Load Capacity

Struck Capacity: 11 m³

SAF 3.1  
Capacity: 14 m³

SAF 1.1  
Capacity: 19 m³

SAF 2.1  
Capacity with  
Autogate: 14.5 m³

Rated Payload: 25,200 kg

### Available Equipment

#### Cab

- ROPS/FOPS certification
- Protective rear window guard
- Tilt cab for service access
- Gas strut supported door
- Tinted safety glass
- Sliding windows
- Rear view mirrors - regular and wide angle
- Sun visor
- Wiper/washer with intermittent control
- Tilt and telescoping steering wheel
- Adjustable, air suspension seat with retractable seat belt

# Productivity

Hourly productivity can be determined by the following equation.

$$V = \frac{3600 \times Q \times K \times E}{C \times D}$$

Where: V = hourly productivity, m<sup>3</sup>/h  
 Q = bucket capacity (heaped), m<sup>3</sup>  
 K = bucket factor (see Table 1)  
 E = work efficiency (see Table 2)  
 C = basic cycle time (sec)  
 D = factor between swing angle and digging depth (see Table 3)

## Bucket Factor (K)

Bucket factor (K) varies with kind of soil and digging depth. Cumulative data, obtained depending on kind and conditions of soil, are generally used for actual planning.

Table 1 Bucket Factor (K)  
 (Using JIS bucket capacity definition)

Type of Excavation	Light excavation	Medium excavation	Relatively tough excavation	Tough excavation
K	0.8 - 1.0	0.7 - 0.9	0.6 - 0.8	0.4 - 0.7
Kind and conditions of soil	Loose sand; easily heaped condensed soil with little air void in bucket; and clay containing lots of sand.	Easily collapsed soil when stockpiled (no blasting required); sand and soil loaded in bucket with air void; wet or dry clay; coarse gravel; and compacted sand and soil.	Finely crushed limestone and sandstone; wet cohesive clay; gravel containing rubble; and excavation in water.	Bulky blasted rocks loaded in bucket with large air void.

## Work Efficiency (E)

Work efficiency (E) varies largely with operator's skill as well as machine travel distance, preparation time length and dump trucks combined. Actual work efficiency is from 0.5 to 0.8.

Table 2 Work Efficiency (E)

Work Conditions	Work Efficiency
Very good	0.9 (55 minutes/hour)
Good	0.83 (50 minutes/hour)
Ordinary	0.75 (45 minutes/hour)





### Hourly Production (Loose Soil Volume) (V)

Hourly production (V) of each model in light excavation is tabulated below for reference.

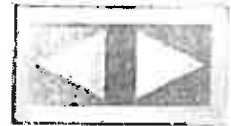
$$V = \frac{3600 \times Q \times K \times F}{C \times D}$$

where K = 0.9  
E = 0.9  
D = 1.0

### Hourly Production (Loose Soil Volume) (V)

Unit: m<sup>3</sup>/h

	Bucket Capacity (Q) (heaped) m <sup>3</sup>	Work Efficiency (E)			
		1.0	0.83	0.75	0.6
ZX70	0.28	70	58	53	35
ZX110	0.45	112	93	84	58
ZX120	0.5	125	104	94	63
ZX160LC	0.6	139	115	104	70
ZX200	0.8	185	154	139	93
ZX230	1.0	203	168	152	102
ZX270	1.1	223	185	167	112
ZX330	1.4	284	236	213	142
ZX450	1.8	324	269	243	162
ZX600	2.5	428	354	320	213
ZX800	3.3	535	444	401	268
EX1200-6C	5.0	736	611	552	368
EX1900-6	12.0	1 244	1 033	933	622
EX2500-6	15.0	1 800	1 494	1 350	900
EX3600-6	22.0	2 546	2 113	1 910	1 273
EX5500-6	29.0	3 132	2 600	2 349	1 566



## Basic Cycle Time (C)

Cycle time varies with kind and conditions of soil as well as the degree of excavation difficulty. Here, basic cycle time (C) is defined on condition that kind of soil is ordinary, swing angle is 90°, digging depth is 60% maximum digging depth (catalog data), and operation is dumping onto a well matched dump truck.

Basic Cycle Time (C)

	Basic Cycle Time	Unit, sec
		Mode
ZX70/ZX70LC	13	Maximum output mode
ZX110/ZX110M	13	Maximum output mode
ZX120	13	Maximum output mode
ZX130LC	14	Maximum output mode
ZX200	14	Maximum output mode
ZX230	16	Maximum output mode
ZX270	18	Maximum output mode
ZX330	16	Maximum output mode
ZX450	18	Maximum output mode
ZX600	19	Maximum output mode
ZX800	20	Maximum output mode
EX1200-5C	22	Maximum output mode
EX1900-5	25	Maximum output mode
EX2500-5	27	Maximum output mode
EX3600-5	28	Maximum output mode
EX5500-5	30	Maximum output mode

## Factor between Swing Angle and Digging Depth (D)

Cycle time varies with swing speed and digging depth.

Table 3 Factor between Swing Angle and Digging Depth

Digging Depth	Swing Angle			
	45°	90°	135°	180°
Less than 40% maximum digging depth	0.80	0.85	0.95	1.05
40% to 75% maximum digging depth	0.95	1.00	1.10	1.20
More than 75% maximum digging depth	1.10	1.15	1.25	1.40

(3) Every contractor shall consult with the health and safety committee or, if no health and safety committee exists, with a representative group of employees, on the development, monitoring and review of the risk assessment.

(4) A contractor shall ensure that all employees under the his or her control are informed, instructed and trained by a competent person regarding any hazard and the related work procedures before any work commences, and thereafter at such times as may be determined in the risk assessment.

(5) A principal contractor shall ensure that all contractors are informed regarding any hazard as stipulated in the risk assessment before any work commences, and thereafter at such times as may be determined in the risk assessment.

(6) A contractor shall ensure that as far as is reasonably practicable, ergonomic related hazards are analysed, evaluated and addressed in the risk assessment.

(7) Notwithstanding the requirements laid down in subregulation (4), no contractor shall allow or permit any employee to enter any site, unless such person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry.

(8) A contractor shall ensure that all visitors to a construction site undergoes health and safety instruction pertaining to the hazards prevalent on the site and shall be provided with the necessary personal protective equipment: Provided that where visits are made only to the site office which is not in direct contact with the construction work activities, those health and safety instructions and the provision of personal protective equipment may not apply.

(9) Every employee on site shall-

- (a) be in possession of proof of the health and safety induction training as determined in subregulation (7), issued by a competent person of the contractor prior to the commencement of construction work; and
- (b) carry the proof contemplated in paragraph (a) for the duration of that project or for the period that the employee will be on the construction site.

#### **Fall protection**

**8.(1) A contractor shall cause—**

- (a) the designation of a competent person, responsible for the preparation of a fall protection plan;
- (b) the fall protection plan contemplated in (a) to be implemented, amended where and when necessary and maintained as required;
- (c) steps to be taken in order to ensure the continued adherence to the fall protection plan.

(2) The fall protection plan contemplated in subregulation (1), shall include—

- (a) a risk assessment of all work carried out from an elevated position which shall include the procedures and methods used to address all the risks identified per location;
- (b) the processes for evaluation of the employees physical and psychological fitness necessary to work at elevated positions and the records thereof;
- (c) the programme for the training of employees working from elevated positions and records thereof; and
- (d) the procedure addressing the inspection, testing and maintenance of all fall protection equipment.

(3) A contractor shall ensure that the construction supervisor appointed in terms of regulation 6(1), is in possession of the most recently updated version of the fall protection plan.

(4) Notwithstanding the provisions of subregulations (1) and (2), the contractor shall ensure that—

- (a) all unprotected openings in floors, edges, slabs, hatchways and stairways are adequately guarded, fenced or barricaded or that similar means are used to safeguard any person from falling through such openings;
- (b) no person works in an elevated position, unless such work is performed safely as if working from a scaffold or ladder;
- (c) notices are conspicuously placed at all openings where the possibility exists that a person might fall through such openings;
- (d) fall prevention and fall arrest equipment is—
  - (i) suitable and of sufficient strength for the purpose or purposes for which it is being used having regard to the work being carried out and the load, including any person, it is intended to bear; and
  - (ii) securely attached to a structure or plant and the structure or plant and the means of attachment thereto is suitable and of sufficient strength and stability for the purpose of safely supporting the equipment and any person who is liable to fall;
- (e) fall arrest equipment shall only be used where it is not reasonably practicable to use fall prevention equipment; and
- (f) suitable and sufficient steps shall be taken to ensure, as far as is reasonably practicable, that in the event of a fall by any person, the fall arrest equipment or the surrounding environment does not cause injury to the person.

## **Excavation work**

**11.(1)** A contractor shall ensure that all excavation work is carried out under the supervision of a competent person who has been appointed in writing.

(2) A contractor shall evaluate, as far as is reasonably practicable, the stability of the ground before excavation work begins.

(3) Every contractor who performs excavation work shall—

- (a) take suitable and sufficient steps in order to prevent, as far as is reasonably practicable, any person from being buried or trapped by a fall or dislodgement of material in an excavation;
- (b) not require or permit any person to work in an excavation which has not been adequately shored or braced: Provided that shoring and bracing may not be necessary where—
  - (i) the sides of the excavation are sloped to at least the maximum angle of repose measured relative to the horizontal plane; or
  - (ii) such an excavation is in stable material: Provided that—
    - (aa) permission being given in writing by the appointed competent person contemplated in subregulation (1) upon evaluation by him or her of the site conditions; and
    - (bb) where any uncertainty pertaining to the stability of the soil still exists, the decision from a professional engineer or a professional technologist competent in excavations shall be decisive and such a decision shall be noted in writing and signed by both the competent person contemplated in subregulation (1) and the professional engineer or technologist, as the case may be;
- (c) take steps to ensure that the shoring or bracing contemplated in paragraph (b) is designed and constructed in such a manner rendering it strong enough to support the sides of the excavation in question;
- (d) ensure that no load, material, plant or equipment is placed or moved near the edge of any excavation where it is likely to cause its collapse and thereby endangering the safety of, any person, unless precautions such as the provision of sufficient and suitable shoring or bracing are taken to prevent the sides from collapsing;
- (e) ensure that where the stability of an adjoining building, structure or road is likely to be affected by the making of an excavation, the steps are taken that may be necessary to ensure the stability of such building, structure or road and the safety of persons;
- (f) cause convenient and safe means of access to be provided to every excavation in which persons are required to work and such access shall not be further than 6m from the point where any worker within the excavation is working;

- (g) ascertain as far as is reasonably practicable the location and nature of electricity, water, gas or other similar services which may in any way be affected by the work to be performed, and shall before the commencement of excavation work that may affect any such service, take the steps that may be necessary to render the circumstances safe for all persons involved;
- (h) cause every excavation, including all bracing and shoring, to be inspected—
  - (i) daily, prior to each shift;
  - (ii) after every blasting operation;
  - (iii) after an unexpected fall of ground;
  - (iv) after substantial damage to supports; and
  - (v) after rain,

by the competent person contemplated in subregulation (1), in order to pronounce the safety of the excavation to ensure the safety of persons, and those results are to be recorded in a register kept on site and made available to an inspector, client, client's agent, contractor or employee upon request;
- (i) cause every excavation which is accessible to the public or which is adjacent to public roads or thoroughfares, or whereby the safety of persons may be endangered, to be—
  - (i) adequately protected by a barrier or fence of at least one metre in height and as close to the excavation as is practicable; and
  - (ii) provided with warning illuminants or any other clearly visible boundary indicators at night or when visibility is poor;
- (j) ensure that all precautionary measures as stipulated for confined spaces as determined in the General Safety Regulations promulgated by Government Notice No.R.1031 of 30 May 1986, as amended, are complied with when entering any excavation;
- (k) ensure that, where the excavation work involves the use of explosives, a method statement is developed in accordance with the applicable explosives legislation, by an appointed person who is competent in the use of explosives for excavation work and that the procedures therein are followed; and
- (l) cause warning signs to be positioned next to an excavation within which persons are working or carrying out inspections or tests.

## **Demolition work**

**12.(1)** A contractor shall appoint a competent person in writing to supervise and control all demolition work on site.



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Name

Date

O / O Costs Machine:

Number

- 1 Working Hours
- 1.1 Per month
- 1.2 Per year
- 1.3 Per Day
- 1.4 Rer week


- 2 Purchase
- Residual Value %
- First set of Tyres

Price

Monthly payback

Hourly

- 3 Insurance %

Total Owning cost

- 4 Fuel

- 5 Planned Maintenance

- 6 Moving

- 6.1 Tyre Replace

- 6.2 Undercarridge

- 7 Repair Cost

- 8 GET

Total Operating Cost

- 9 Operator

Total Operator Cost

Total Cost

Totals

R/Hour





Examination 2014 CMC411

Name

Date

O / O Costs Machine:

Number

- 1 Working Hours
- 1.1 Per month
- 1.2 Per year
- 1.3 Per Day
- 1.4 Per week


- 2 Purchase
- Residual Value %
- First set of Tyres
- Price
- Monthly payback
- Hourly

- 3 Insurance %

**Total Owning cost**

- 4 Fuel

- 5 Planned Maintenance

- 6 Moving

- 6.1 Tyre Replace

- 6.2 Undercarriage

- 7 Repair Cost

- 8 GET

**Total Operating Cost**

- 9 Operator

**Total Operator Cost**

**Total Cost**

Totals

R/Hour

