ABC STUDIES AND ANALYSIS OF CONCRETE UNIT PRICES

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ABSTRACT

This article is the continuation of our articles, published on the same site IJARIIE which have a reference ISSN (O): 2395-4396, Paper id: 11241, whose title is the contribution to the study of high-compact fluid concretes: formulations and characterizations; and a Paper id 11270, a title of Modelling of fluid concretes by experimental designs.

After the formulation and modeling of the three ordinary concretes and twenty-one high-compact fluid concretes, the study and the price analysis of these concretes were carried out.

These concretes are formulated from the same materials, but the quantity and dosage that make them different. We referred to the quantities of gravel, sand, cement, water and admixture, to be able to evaluate the unit prices of concretes.

The unit prices of concretes generally depend on the price of materials, on the wages needed to pay for labour and on the amount of money that must be set aside to provide for the depreciation of materials and tools. Various overheads are also included in the unit prices.

In order to make a decision on the use of concrete types on the construction site, the ABC analysis allows evaluating concretes that have the lowest prices but good qualities.

Keyword: *Concrete, Unit Prices, Materials, Fees, Disbursements, PARETO Diagram*.

1. INTRODUCTION

To highlight the research we have done on the formulation and mathematical modeling of fluid concretes with high compactness, we will study, for the continuation; the studies of the price of the confections of the various concretes per cubic meter.

We study in tables the unit prices of concretes by detailing the costs of materials, the costs of labour and the costs of materials of these various concretes. PARETO's diagrams and analysis are used to make a decision on the use of concrete

2. CONCRETE PRICE STUDIES

2.1. Unit Price

The unit price of a concrete is given by the relation: $PU \approx \frac{D \times K_1}{R}$

D: the dry disbursements that derive from the combination of the unit prices of materials, equipment and labour. It is the totality of all expenses for the purchase of materials, for the wages of the executing workers and for the rental or depreciation of materials or tools.

K_1 : le coefficient de deboursé appelé traditionnellement coefficient d'adjudication "c". This is the coefficient which allows the influence of construction costs, overheads and costs proportional to the selling price and of course the profit to be introduced into the unit prices and which is detailed below.

The disbursement coefficient K1 is defined by the following formula:

$$K_1 \approx \frac{\left(\frac{1+A_1}{100}\right)\left(\frac{1+A_2}{100}\right)}{1-\left(\frac{A_3}{100}\times\left(1+\frac{TVA}{100}\right)\right)}$$

With A1: Overheads proportional to disbursements A1 = a1 + a2 + a3

(Agency and patent fees (a1), Building site costs (a2), Study costs (a3), Assurance (a4))

A2: Gross profit and financial costs proportional to the cost price of the company A2 = a5 + a6 + a7 + a8

(Bénéfice net et impôt sur le bénéfice (a5), Aléas technique (a6), Aléas de révision des prix (a7), Frais financiers (a8))

A3: Fee proportional to the settlement price with tax A3 = a9

(Frais de siège (a9))

The calculation detail of K1 is given in the following table 1:

Table 1: Calculation details for disbursement coefficient K1

Overheads proportional to disbursements A1				Gross profit and expenses Financial A2				Fees proportional to settlement prices with Tax A3
a1	a2	a3	a4	a5	a6	a7	a8	a9
3%	10%	4%	5%	10%	4%	3%	2%	0
A1 = 22%				A2 = 19%				A3 = 0
K1 = 1.45								

If the concrete batching plant company has its headquarters in Madagascar a9 = 0

2.2. Summary of the dosages of each constituent of concretes

The dosages of each constituent of three ordinary concretes BO1, BO2 and BO3 in one cubic meter are given in the following table 2:

Table -2 : Doses of each constituent of BO1 and BO2 in one cubic metre

BO1				BO2						BO3					
C [Kg]	E [L]	Sr1 [Kg]	g1 [Kg]	C [Kg]	E [L]	Sc [Kg]	Sr2 [Kg]	g2 [Kg]	G [Kg]	C [Kg]	E [L]	Sc [Kg]	Sr2 [Kg]	g2 [Kg]	G [Kg]
400	220	752	992	350	203	262	491	292	815	350	170	301	292.6	1045.2	1043.2

The dosages of each component of twenty-one high-compact fluid concretes are presented in the following Table 3 and Table 4:

Table-3: Doses of each constituent of BFL1 in one cubic metre in 1 m3

SAND [Kg]	GRAVEL [Kg]	C CEMENT CEM II-A-42,5 [Kg]	FILLER CIPOLIN [Kg]	SIKA VISCOCRETE TEMPO 12 [L]	WATER [L]
Sr1	g1	C	Fcp	Sp1	E
672	672	400	220	7	220

Table 4: Dosages de chaque constituants des bétons fluides BFL2 à BFL21

FLUID CONCRETE N°	C [Kg]	E[L]	g2[Kg]	G [Kg]	Sr2[Kg]	Sc[Kg]	F		Sp	
							Fcp[Kg]	Fd[Kg]	Sp1[L]	Sp2[L]
BFL2	350	203	368	368	368	368	193	-	7	-
BFL3	350	203	368	368	368	368	-	193	7	-
BFL4	350	203	368	368	368	368	193	-	-	7
BFL5	350	203	368	368	368	368	-	193	-	7
BFL6	350	192 ,5	368	368	368	368	96,5	96,5	3,5	3,5
BFL7	400	192 ,5	368	368	368	368	96,5	96,5	3,5	3,5
BFL8	350	220	368	368	368	368	96,5	96,5	3,5	3,5
BFL9	400	220	368	368	368	368	96,5	96,5	3,5	3,5
BFL10	350	192 ,5	368	368	368	368	115,8	77,2	3,5	3,5
BFL11	400	192 ,5	368	368	368	368	115,8	77,2	3,5	3,5
BFL12	350	220	368	368	368	368	115,8	77,2	3,5	3,5
BFL13	400	220	368	368	368	368	115,8	77,2	3,5	3,5
BFL14	350	192 ,5	368	368	368	368	96,5	96,5	4,2	2,8
BFL15	400	192 ,5	368	368	368	368	96,5	96,5	4,2	2,8
BFL16	350	220	368	368	368	368	96,5	96,5	4,2	2,8
BFL17	400	220	368	368	368	368	96,5	96,5	4,2	2,8
BFL18	350	192 ,5	368	368	368	368	115,8	77,2	4,2	2,8
BFL19	400	192 ,5	368	368	368	368	115,8	77,2	4,2	2,8
BFL20	350	220	368	368	368	368	115,8	77,2	4,2	2,8
BFL21	400	220	368	368	368	368	115,8	77,2	4,2	2,8

2.2. Award Series

The 1962 price extract giving the unit times of workers, materials and tools in Madagascar is shown in table 2 below.

Tableau 1: Excerpt from the 1962 series of awards giving unit times, workers, materials and tools

EXCERPT FROM THE 1962 SERIES OF AWARDS GIVING UNIT TIMES, WORKERS, MATERIALS AND TOOLS IN MADAGASCAR					
PRICE NUMBER	DESIGNATION	UNIT	QUANTITIES	UNIT WORKING TIME	UNIT TIME TO MANEUVER
3686+3268	Concrete dosed at 350kg/m3 (m3)				
	Team Leader	h		2,5	
	Mason	h		5	
	Maneuver	h			16
	Concrete mixer	h	2,5		
	Pervibrator	h	2,5		
	Mason's tools	h	5		
3930+3255	Concrete dosed at 400kg/m3 (m3)				
	Team Leader	h		2,5	
	Mason	h		5	
	Maneuver	h			16
	Concrete mixer	h	2,5		
	Pervibrator	h	2,5		
	Mason's tools	h	5		

2.3. Unit price of fluid concretes

Some sub details of concrete unit prices are presented in the following tables:

Table 3: Unit price details for BO1

ORDINARY CONCRETE BO1							
DESIGNATION	U	QUANTITIES	UNIT PRICE [Ar]	MATERIALS [Ar]	WORKFORCE [Ar]	EQUIPMENT [Ar]	TOTAL [Ar]
A - MATERIALS							
Cement	Kg	400	640	256000			
Water	m3	0,22	1250	275			
Gravel g1	m3	0,379	80000	30320			
Gravel G	m3	-	-	-			
Sand Sr1	m3	0,514	44000	22616,54			
Sand Sc	Kg	-	-	-			
Filler Cipolin FC	Kg	-	-	-			
Filler Dolomie FD	Kg	-	-	-			
Superplasticizer Sp1	L	-	-	-			
Superplasticizer Sp2	L	-	-	-			
TOTAL MATERIALS							309211,5

							4
B - WORKFORCE							
Team Leader	h	2,5	2000		5000		
Mason	h	5	1800		9000		
Maneuver	h	16	1500		24000		
TOTAL WORKFORCE							38000,00
C - EQUIPEMENT							
Concrete mixer	h	2,5	7000			17500	
Pervibrator	h	2,5	7000			17500	
Mason's tools	h	5	3000			15000	
TOTAL EQUIPMENT							50000
K1	1,45			DISBURSED			397211,54
PERFORMANCE	1			UNIT PRICE			575 957

Table 4: Under Unit Price Details of BFL1

FLUID CONCRETE BFL1							
DESIGNATION	U	QUANTITIES	UNIT PRICE [Ar]	MATERIALS [Ar]	WORKFORCE [Ar]	EQUIPMENT [Ar]	TOTAL [Ar]
A - MATERIALS							
Cement	Kg	400	640	256000			
Water	m3	0,22	1250	275			
Gravel g1	m3	0,264	80000	21120			
Gravel G	m3	-	-	-			
Sand Sr1	m3	0,471	44000	20724			
Sand Sc	Kg	-	-	-			
Filler Cipolin FC	Kg	180	400	72000			
Filler Dolomie FD	Kg	-	-	-			
Superplasticizer Sp1	L	7	650	4550			
Superplasticizer Sp2	L	-	-	-			
TOTAL MATERIALS							374669
B - WORKFORCE							
Team Leader	h	0,5	2000		1000		
Mason	h	1	1800		1800		
Maneuver	h	1,5	1500		2250		
TOTAL MAIN D'ŒUVRE							5050
C - EQUIPEMENT							
Concrete mixer	h	1	7000			7000	
Pervibrator	h	-	-			-	
Mason's tools	h	1,2	3000			3600	
TOTAL EQUIPMENT							10600
K1	1,45			DISBURSED			390319
PERFORMANCE	1			UNIT PRICE			565 963

Unit prices for fluid concretes are presented in tables 4, 5 and 6 below:

Table 5: Unit prices for BO1, BO2, BO3 and BFL1 to BFL5

BO1[Ar] (Q400)	BO2[Ar] (Q350)	BO3[Ar] (Q350)	BFL1[Ar] (Q400)	BFL2[Ar] (Q350)	BFL3[Ar] (Q350)	BFL4[Ar] (Q350)	BFL5[Ar] (Q350)
575 957	534 846	565 518	565 963	530 646	536 243	529 776	535 373

Table 6: Unit prices of BFL6 to BFL13

BFL6[Ar] (Q400)	BFL7[Ar] (Q350)	BFL8[Ar] (Q350)	BFL9[Ar] (Q400)	BFL10[Ar] (Q350)	BFL11[Ar] (Q350)	BFL12[Ar] (Q350)	BFL13[Ar] (Q350)
533 879	580 279	533 932	580 332	533 319	579 719	533 372	579 772

Table 7: Unit prices of BFL14 to BFL21

BFL14[Ar] (Q400)	BFL15[Ar] (Q350)	BFL16[Ar] (Q350)	BFL17[Ar] (Q400)	BFL18[Ar] (Q350)	BFL19[Ar] (Q350)	BFL20[Ar] (Q350)	BFL21[Ar] (Q350)
533 741	580 141	533 794	580 194	533 182	579 821	533 234	579 634

2. GENERAL INFORMATION ON THE ABC ANALYSIS

2.1. Principle of ABC analysis

The PARETO diagram allows you to visualize the relative importance of the different parts or categories of a previously analyzed and quantified set in the form of a ranking and hierarchy.

The ABC analysis or PARETO analysis allows to highlight the prices of concretes which have the lowest costs but good qualities in order to guide the action of selling or use on site. The principle is presented in the following figure 1.

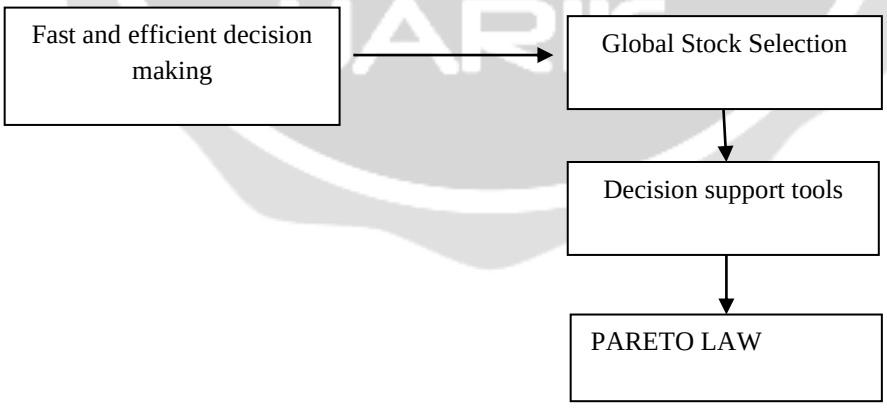

Figure 1: Decision-making

The elements will be ranked in order of importance by indicating the percentages for a given criterion, which requires a three-step approach:

- Define the nature of the elements to be ranked

- Choose the ranking criterion

- Define study boundaries and classify elements

By cumulating the decreasing values of the criterion studied, the ABC curve or PARETO curve shows three zones, hence the name "ABC curve";

Zone A: 20% of the number of elements represent 80% of the criterion studied.

Zone B: the 30% more elements represent 15% more than the criterion studied;

Zone C: The remaining 50% of elements represent only 5% of the criterion studied.

2.3. PARETO diagram

The information given in the table allows you to transfer in an orthonormal marker

- In abscissa, the elements studied in cumulative %,

- On the Y-axis, the cumulative % values of the criterion.

By connecting the points thus obtained, an ascending curve must appear on which the limits of the three groups must be indicated.

2.4. Methodical approach

For a given sector or system, the application of Pareto's law requires several steps:

- Step 1: Make the analysis table which consists of the following 6 columns:

Column n°1: order n° of the products studied;

Column n°2: names or references of the products studied (to be filled in after column n°3);

Column n°3: values of the chosen criterion in descending order;

Column n°4: cumulative increasing values of the chosen criterion;

Column 5: cumulative increasing values of the chosen criterion in percentage;

Column n°6: cumulative percentages of the products studied.

The structure of the table is shown as follows:

Table 8: Table structure of the ABC analysis

Product order number	References of the studied products	Criteria in descending order	Increasing cumulative criteria	Cumulative % increasing criteria	Cumulative percentage of products studied

- Step 2: Graphing the data

In an orthonormal marker, report the cumulative percentages of the products studied on the abscissa, and the values of the chosen criterion increasing in percentage on the ordinate;

Draw the curve connecting the points obtained.

- Step 3: Draw a conclusion and propose a decision

The PARETO table is then represented as follows (Table 9)

Table 9: PARETO's table on concrete unit prices

ORDER NO.	REFERENCES	PU DES BETONS	UNIT PRICE CUMULATIVE GROWING	UNIT PRICE CUMULATIVE %	REFERENCES CCUMULATIVE %	ZONE
1	BFL9	580 332	580332	4,37%	4%	Zone A
2	BFL7	580 279	1160611	8,74%	8%	
3	BFL17	580 194	1740805	13,11%	13%	
4	BFL15	580 141	2320946	17,47%	17%	
5	BFL19	579 821	2900767	21,84%	21%	
6	BFL13	579 772	3480539	26,20%	25%	Zone B
7	BFL11	579 719	4060258	30,57%	29%	
8	BFL21	579 634	4639892	34,93%	33%	
9	BO1	575 957	5215849	39,27%	38%	
10	BFL1	565 963	5781812	43,53%	42%	
11	BO3	565 518	6347330	47,79%	46%	Zone C
12	BFL3	536 243	6883573	51,82%	50%	
13	BFL5	535 373	7418946	55,85%	54%	
14	BO2	534 846	7953792	59,88%	58%	
15	BFL8	533 932	8487724	63,90%	63%	
16	BFL6	533 879	9021603	67,92%	67%	
17	BFL16	533 794	9555397	71,94%	71%	
18	BFL14	533 741	10089138	75,96%	75%	
19	BFL12	533 372	10622510	79,97%	79%	
20	BFL10	533 319	11155829	83,99%	83%	
21	BFL20	533 234	11689063	88,00%	88%	
22	BFL18	533 182	12222245	92,02%	92%	
23	BFL2	530 646	12752891	96,01%	96%	
24	BFL4	529 776	13282667	100,00%	100%	

Ce qui nous donne la figure suivante (Figure 39)

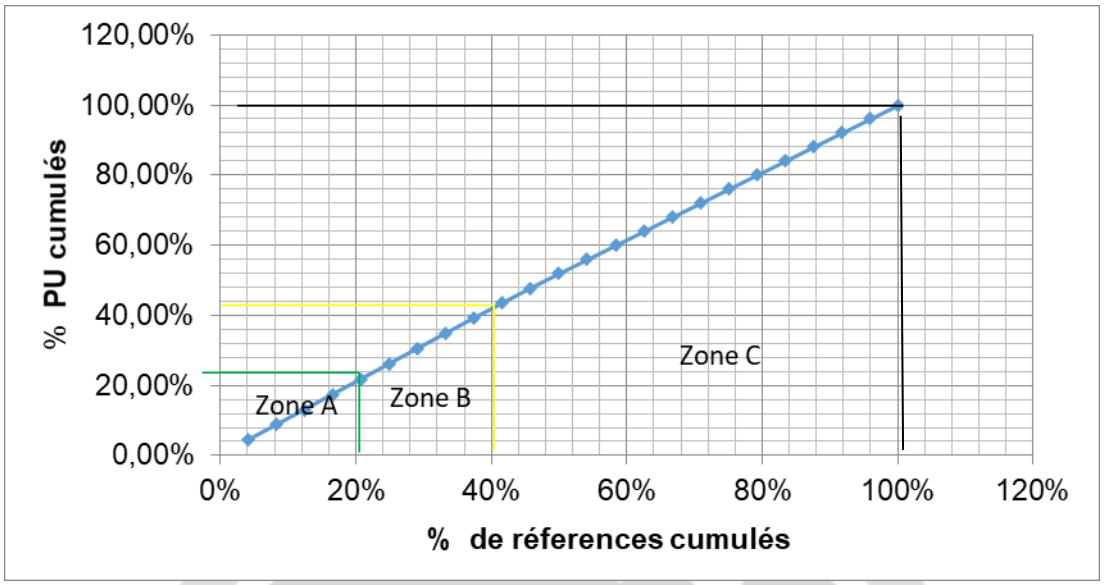

Figure 1: Distribution of zones A, B and C of concrete unit prices

5. CONCLUSION

BFLs generally bring labour savings: no vibration energy and a reduction in the number of workers.

Concrete in zone A (BFL9 , BFL7, BFL17, BFL15, BFL19) and in zone B (BFL13 , BFL11, BFL21, BO1, BFL1) have high costs. This is normal since they have a high cement dosage of 400 Kg. Among these concretes of type Q400, it is preferable to make the fluid concrete BFL11 for the construction of an engineering structure (prestressed concrete bridge,...). This concrete formulated by experimental designs has a low cost but a high compressive strength at 28 days. BFL1 and BO1 are formulated with the same type of materials. The total cost to make one cubic meter of BFL1 fluid concrete is 9994 Ar less than BO1. BFL1 fluid concrete not only provides good compressive strength at 28 days (35.8 MPa for BFL1 and 23.2 MPa for BO2), but also a cost reduction of up to 1.73% compared to BO1. The concretes in zone C are concretes dosed at 350 Kg of cement. These concretes are formulated from identical materials. The target concrete is BFL20 fluid concrete: it has a 28-day compressive strength of 36.1 MPa, but a low cost. Compared to BO3, their cost is 32336 Ar in one cubic meter. Therefore, for a building structure that requires 1000 m3 of concrete, there will be a cost reduction of 32,336,000 Ar, when using BFL20 instead of BO3. The BO3 formula is the most commonly used formula on the building site.

But let's not forget also that BFLs have many advantages on durability (more compact), workability and physical qualities. It is therefore possible to produce a concrete that is more durable and easier to work with, at a lower cost compared to BO.

6. REFERENCES

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