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INTERNATIONAL ITINERANT EXHIBITION



LA HABANA

RESEARCH in BUILDING ENGINEERING



VALENCIA

EXCO'18



UNIVERSITAT  
POLITÈCNICA  
DE VALÈNCIA

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA DE EDIFICACIÓN

ODESSA

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ALBIOL IBÁÑEZ, José Ramón  
MARTÍNEZ BENLLOCH, Jose Javier

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Director EXCO'18



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*CHAPTER 5*

# ***TECHNOLOGY***

*CAPÍTULO 5 TECNOLOGÍA*



## **A MIX DESIGN METHODOLOGY TO PRODUCE HIGH STRENGTH CONCRETE WITH LOCAL MATERIALS IN BOLIVIA STUDY CASE: LA PAZ**

### **Eliseo Jahdiel Villafuerte Oporto**

*Civil Structural Engineer, Universidad Mayor de San Andrés, La Paz, Bolivia.  
Master in Structural Analysis for Historical Constructions. University of Minho, Guimarães, Portugal.  
Chief Technician of the Materials Laboratory, TECNILAB S.R.L, La Paz, Bolivia.  
Email: [jahdiel1634@gmail.com](mailto:jahdiel1634@gmail.com)*

### **Fernando Miguel Cerruto Aníbarro**

*Full Professor, Structural Engineer, Universidad Mayor de San Andrés, La Paz, Bolivia.  
Research professor, Concrete Technology Area, Instituto de Ensayo de Materiales, Universidad Mayor de San Andrés, La Paz, Bolivia.  
Email: [fcerruto@umsa.bo](mailto:fcerruto@umsa.bo)*

### **Luis Adolfo Castro Vega**

*Full Professor Structural Engineer, Universidad Mayor de San Andrés, La Paz, Bolivia.  
Research professor, Structures Area, Instituto de Ensayo de Materiales, Universidad Mayor de San Andrés, La Paz, Bolivia.  
Email: [iem@umsa.bo](mailto:iem@umsa.bo)*

### **Graziella Bernardo**

*Associate Professor, Science and Technology of Materials. Università degli Studi della Basilicata, Matera, Italia.  
Email: [graziella.bernardo@unibas.it](mailto:graziella.bernardo@unibas.it)*

### **Abstract**

At present, there is not a definitive mixing method that can be said to be exclusive for high strength concretes, indeed, many researchers have achieved these concretes without using defined reference curves, but only using simple relations between the amount of coarse and fine aggregate allowed the respective mixture proportion.

This article presents an empirical methodology for designing mixtures for high strength concrete, making use of materials available in La Paz, Bolivia. This methodology presents a theoretical basis on the microstructure of concrete and the appropriate use of local materials that are used in the construction of civil works and can be applied to the construction site in reinforced concrete constructions, taking care that the materials, comply with the recommendations made in this article.

### **Palabras clave**

Mix design, High strength concrete, Compressive strength

# METODOLOGÍA DE DISEÑO DE MEZCLAS PARA PRODUCIR HORMIGON DE ALTA RESISTENCIA CON MATERIALES LOCALES EN BOLIVIA. CASO DE ESTUDIO: LA PAZ

## A MIX DESIGN METHODOLOGY TO PRODUCE HIGH STRENGTH CONCRETE WITH LOCAL MATERIALS IN BOLIVIA. STUDY CASE: LA PAZ

Jahdiel Villafuerte<sup>1</sup>  
DECIM / University of Basilicata<sup>1</sup>

Fernando Cerruto<sup>2</sup>  
IEM / Universidad Mayor de San Andres<sup>2</sup>

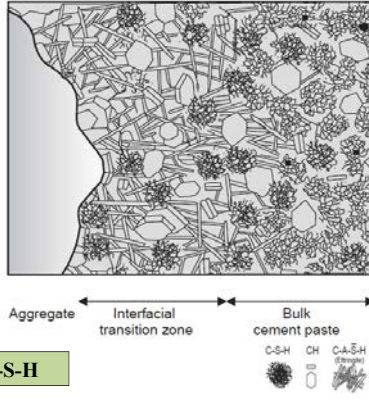
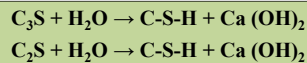
Adolfo Castro<sup>2</sup>  
IEM / Universidad Mayor de San Andres<sup>2</sup>

Graziella Bernardo<sup>1</sup>  
DECIM / University of Basilicata<sup>1</sup>

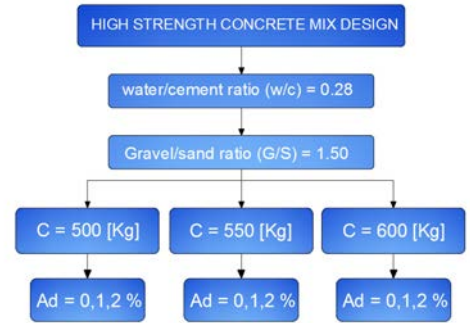


### INTRODUCTION

In Bolivia, the design methods for conventional concrete mixtures, such as the ones proposed by ACI 211.1 and CBH-87, are currently applied in the design of concrete mixtures. But there is no local method to obtain high strength concretes, which, in the global context, has been developing for four decades. In 1963, when the first pre-stressed concrete bridges were built with the post-tensioning system, project characteristic resistances were applied in a range of 35 to 40 MPa, these values are the highest that have been used in the construction of buildings and bridges in Bolivia.



### EXPERIMENTAL PLAN



### MATERIALS

Table 3-a. Physical-mechanical properties of coarse aggregate

Laboratory testing	Value	Standard
Specific gravity	2.526	ASTM C-127
Absorption in %	2.511	ASTM C-127
Loose bulk density kg/m <sup>3</sup>	1456.16	ASTM C-29
Compact bulk density in kg/m <sup>3</sup>	1541.51	ASTM C-29
Voids in %	38.97	ASTM C-29
Resistance to abrasion and degradation in %	15.85	ASTM C-131
Materials finer than 75-µm (No. 200) in %	0.71	ASTM C-117

Table 3-b. Physical-mechanical properties of fine aggregate

Laboratory testing	Value	Standard
Fineness modulus	3.405	ASTM C-136
Specific gravity	2.551	ASTM C-127
Absorption in %	2.324	ASTM C-127
Loose bulk density kg/m <sup>3</sup>	1541.80	ASTM C-29
Compact bulk density in kg/m <sup>3</sup>	1685.93	ASTM C-29
Voids in %	33.90	ASTM C-29
Materials finer than 75-µm (No. 200) in %	1.8	ASTM C-117

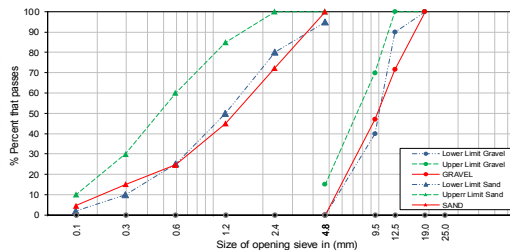


Table 2. Physical-mechanical properties of the cement

Cement	Type	Category Resistant <sup>1</sup>	Specific gravity	Standard
"Viacha Estándar"	IP-30	30 MPa	2.985	ASTM C188

Table 4. Properties of hyper-fluidifying admixture PROTEX CP-WB

Parameter	Unit	Value (*)
Density	(Kg/l)	1.13



### MIX DESIGN

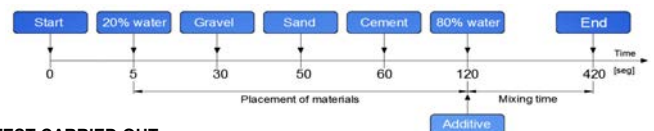
Designation	C (kg/m <sup>3</sup> )	w/C	G/S	w (kg/m <sup>3</sup> )	G (kg/m <sup>3</sup> )	A (kg/m <sup>3</sup> )	Ad (%)
C500-0	500	0.28	1.50	140	1101.6	697.6	0
C500-1	500	0.28	1.50	140	1101.6	696.1	1
C500-2	500	0.28	1.50	140	1101.6	696.1	2
C550-0	550	0.28	1.50	154	965.3	665.7	0
C550-1	550	0.28	1.50	154	965.3	665.7	1
C550-2	550	0.28	1.50	154	965.3	665.7	2
C600-0	600	0.28	1.50	168	919.0	633.8	0
C600-1	600	0.28	1.50	168	919.0	633.8	1
C600-2	600	0.28	1.50	168	919.0	633.8	2

C = Cement content  
w/C = water / cement ratio  
G/S = Gravel/Sand ratio.  
w = water in kg/m<sup>3</sup>

G = Gravel content in kg/m<sup>3</sup>  
S = Sand content in kg/m<sup>3</sup>  
Ad = Additive content in %

$$1 [m^3 \text{ concrete}] = \frac{a}{\gamma_{\text{water}} \cdot 1000} + \frac{c}{\gamma_{\text{cement}} \cdot 1000} + \frac{(G/S) \cdot S}{\gamma_{\text{gravel}} \cdot 1000} + \frac{S}{\gamma_{\text{sand}} \cdot 1000} + \% \text{air}$$

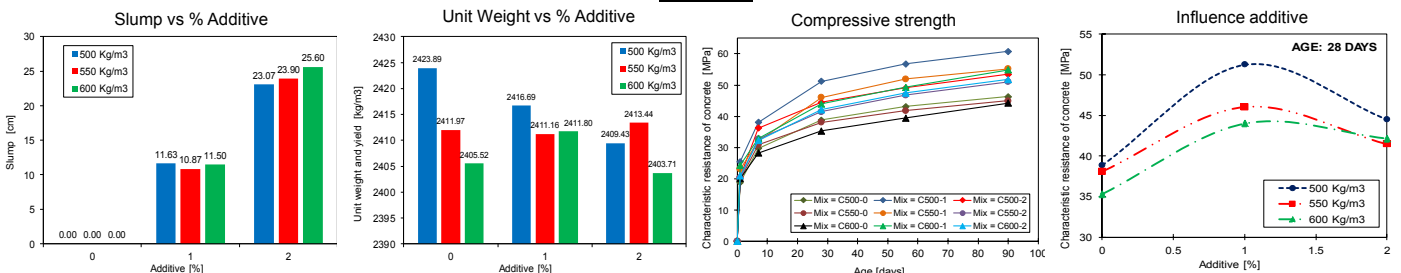
### MIXING PROCEDURE



### TEST CARRIED OUT



### RESULTS



### CONCLUSIONS

- This method can be used to obtain high strength concrete, recommending that the amount of cement should not be greater than 500 kg/m<sup>3</sup> and maximum additive of 1% amount.
- Special care in the particle-size distribution of aggregate and the fineness module of the aggregates, the low water/cement (w/C) ratio must be compensated with the use of a high-range water reducing additive.
- It is recommended to carry out test mixtures in the field, before their application in reinforced concrete works.



MILANO



VIENNA

CATÁLOGO



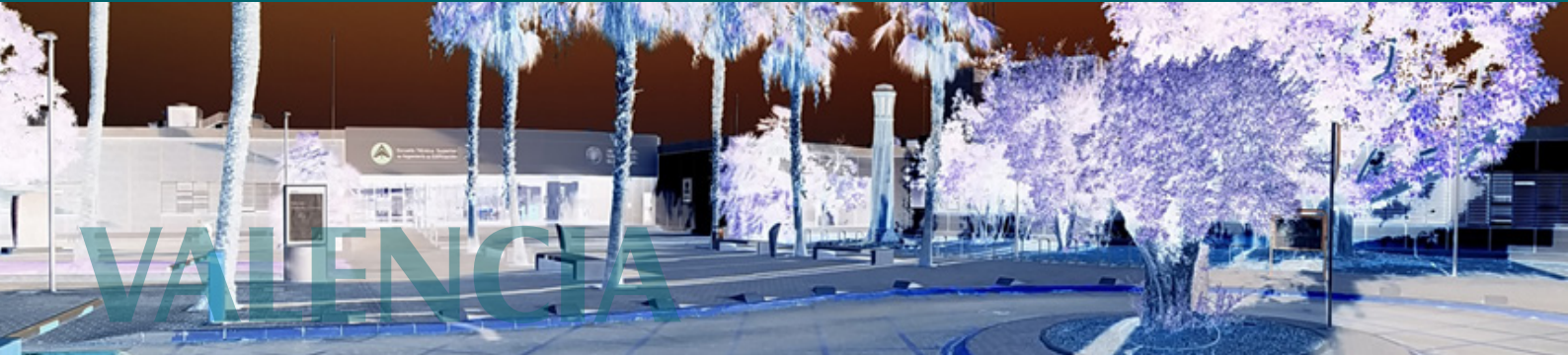
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EXPOSICIÓN ITINERANTE INTERNACIONAL



LA HABANA

INVESTIGANDO en INGENIERÍA de EDIFICACIÓN



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