



MINING AND TUNNELING

*SPECIAL CEMENTS FOR
TUNNEL AND MINING
TECHNOLOGY*



INTRODUCTION

THE COMMON CEMENTS

The Common Cements are well defined in the Cement Standards Worldwide , ASTM , EN , etc. So, if we choose the EN 197, possibly the most detailed in the description of cements, we have the following Common Cements:

Tipos princi- pales	Designación y denominación de los 27 productos (tipos de cementos comunes)		Composición (proporción en masa ¹)										
			Componentes principales									Componentes minoritarios adicionales	
			Clínker	Escoria de horno alto	Humo de sílice	Puzolana		Ceniza volante		Esquisto calcinado	Caliza		
						natural	natural calcinada	silíceas	calcáreas		L		LL
			K	S	D ²	P	Q	V	W	T			
CEM I	Cemento Portland	CEM I	95-100	-	-	-	-	-	-	-	-	-	0-5
CEM II	Cemento Portland con escoria	CEM II/A-S	80-94	6-20	-	-	-	-	-	-	-	-	0-5
		CEM II/B-S	65-79	21-35	-	-	-	-	-	-	-	-	0-5
	Cemento Portland con humo de sílice	CEM II/A-D	90-94	-	6-10	-	-	-	-	-	-	-	0-5
	Cemento Portland con puzolana	CEM II/A-P	80-94	-	-	6-20	-	-	-	-	-	-	0-5
		CEM II/B-P	65-79	-	-	21-35	-	-	-	-	-	-	0-5
		CEM II/A-Q	80-94	-	-	-	6-20	-	-	-	-	-	0-5
		CEM II/B-Q	65-79	-	-	-	21-35	-	-	-	-	-	0-5
	Cemento Portland con ceniza volante	CEM II/A-V	80-94	-	-	-	-	6-20	-	-	-	-	0-5
		CEM II/B-V	65-79	-	-	-	-	21-35	-	-	-	-	0-5
		CEM II/A-W	80-94	-	-	-	-	-	6-20	-	-	-	0-5
		CEM II/B-W	65-79	-	-	-	-	-	21-35	-	-	-	0-5
	Cemento Portland con esquisto calcinado	CEM II/A-T	80-94	-	-	-	-	-	-	6-20	-	-	0-5
		CEM II/B-T	65-79	-	-	-	-	-	-	21-35	-	-	0-5
	Cemento Portland con caliza	CEM II/A-L	80-94	-	-	-	-	-	-	-	6-20	-	0-5
		CEM II/B-L	65-79	-	-	-	-	-	-	-	21-35	-	0-5
		CEM II/A-LL	80-94	-	-	-	-	-	-	-	-	6-20	0-5
		CEM II/B-LL	65-79	-	-	-	-	-	-	-	-	21-35	0-5
	Cemento Portland compuesto ³	CEM II/A-M	80-88	12-20									0-5
		CEM II/B-M	65-79	21-35									0-5
CEM III	Cemento de horno alto	CEM III/A	35-64	36-65	-	-	-	-	-	-	-	-	0-5
		CEM III/B	20-34	66-80	-	-	-	-	-	-	-	-	0-5
		CEM III/C	5-19	81-95	-	-	-	-	-	-	-	-	0-5
CEM IV	Cemento puzolánico ³	CEM IV/A	65-89	-	11-35					-	-	-	0-5
		CEM IV/B	45-64	-	36-55					-	-	-	0-5
CEM V	Cemento compuesto ³	CEM V/A	40-64	18-30	-	18-30			-	-	-	-	0-5
		CEM V/B	20-38	31-49	-	31-49			-	-	-	-	0-5

¹ Los valores de la tabla se refieren a la suma de los componentes principales y minoritarios adicionales.

² La proporción de humo de sílice está limitada al 10%.

³ En los cementos Portland compuestos CEM II/A-M y CEM II/B-M, en los cementos puzolánicos CEM IV/A y CEM IV/B y en los cementos compuestos CEM V/A y CEM V/B, los componentes principales diferentes del clínker se deben declarar en la designación del cemento.

Clase de resistencia	Resistencia a compresión Mpa				Tiempo de principio de fraguado	Estabilidad de volumen (expansión)
	Resistencia inicial		Resistencia nominal			
	2 días	7 días	28 días			
32,5 L*	-	≥ 12,0	≥ 32,5	≤ 52,5	≥ 75	≤ 10
32,5 N	-	≥ 16,0				
32,5 R	≥ 10,0	-				
42,5 L*	-	≥ 16,0	≥ 42,5	≤ 62,5	≥ 60	
42,5 N	≥ 10,0	-				
42,5 R	≥ 10,0	-				
52,5 L*	≥ 10,0	-	≥ 52,5	-	≥ 45	
52,5 N	≥ 10,0	-				
52,5 R	≥ 10,0	-				

* Clase de resistencia definida sólo para los cementos CEM III

THE SPECIAL CEMENTS

Special cements are those that comply with the regulations and the requirements of the common cements, have a number of important features for certain applications, such as: grain size, viscosity, density and setting time; in addition to mechanical requirements that give exceptional performance in a short time.

The Special Cements of CEMENT INTERNATIONAL TECHNOLOGIES meet global standards of cements so its use is covered by the extensive experience and knowledge in them, especially in their **durability guarantees**.



SPECIAL CEMENTS DEVELOPED BY C.I.T.

OUR SPECIAL CEMENTS

ULTRAVAL

ULTRAVAL SR

MICROVAL TP32

MICROVAL TP 12

RAPIDVAL

ULTRAVAL is a **common cement** that meets ASTM Standards, EN Standards and other worldwide standards. And it is a Special Cement because it meets more stringent specifications:

- **giving 50 MPa to a single day** (with a lower statistical of 42 Mpa), instead of the standard 30 MPa at 2 days.
- **giving 70 MPa at 28 days** (with a lower statistical of 65 Mpa), instead of the standard 52,5 MPa.
- Is a low alkali cement with Na_2O equivalent lower than 0.60%.

Like a common cement, ULTRAVAL has the next characteristics:

- **Depending on its composition:** It is a CEM I cement according to the European standard or a Type III cement according ASTM.
- **Depending on its mechanical properties:** It is a CEM I 52.5 R cement category according to the European standard or a Type III cement according ASTM.

ULTRAVAL. TECHNICAL SHEET

- Class cement **CEM I 52,5 R** according to the European Standard **UNE-EN 197-1: 2011**, which means that it is composed of portland clinker and gypsum.
- D_{95} equal to 24 microns (allowing the Ultraval achieve category microcement).
- Blaine above 7.000 cm²/g.
- C_3A lower than 10%.
- Na_2O equivalent lower than 0,60%.
- SO_3 lower than 3,2%.
- Cl^- lower than 0,05%.
- Compressive strength at 1 day above 42 MPa**
- Compressive strength at 2 days above 50 MPa**
- Compressive strength at 28 days above 65 MPa**

** Tested according European Standards.







Cementos Portland Valderrivas, S.A. **FÁBRICA: OLAZAGUTIA**
Certificado ER: ER-0878/1997

CERTIFICADO DE CARACTERÍSTICAS TÉCNICAS

Cemento	Periodo
CEM I 52,5R UltraVal CEM I 52,5R	diciembre de 2012
CE: 0099/CPD/A33/0836	

ENSAYOS	Resultados Valor Promedio	Especificación Norma EN/UNE
Características Químicas		
Pérdida por Calcinación/Pérdida al fuego	%	1,7
Residuo Insoluble	%	0,1
Sulfatos (SO ₃)	%	3,2
Cloruros	%	0,02
Características Físicas y Mecánicas		
Agua de Consistencia Normal	%	30,6
Principio de Fraguado	min	86
Final de Fraguado	min	135
Expansión Le Chatelier	mm	0,3
Superficie específica (Blaine)	cm ² /g	7538
Resistencia mecánica a compresión a 2 días	MPa	
• Media mensual	56,3	> 30,0
• Media acumulada (01/2012 - 12/2012)	56,4	> 30,0
• Desv. Std. acumulada (01/2012 - 12/2012)	1,4	
Resistencia mecánica a compresión a 28 días	MPa	
• Media mensual	74,5	> 52,5
• Media acumulada (01/2012 - 12/2012)	73,3	> 52,5
• Desv. Std. acumulada (01/2012 - 12/2012)	1,7	

El presente documento no implica que por parte de la Empresa se haya suministrado cantidad alguna de cemento

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Jefe de Control de Calidad





ULTRAVAL SR cement has equivalent properties to cement ULTRAVAL but with a new special property:

- C_3A content is lower than 3%. This characteristic, according to the European Standard, classifies it as **cement with very high resistance to sulphates and seawater**.
- and is a **very low alkali cement** with Na_2O equivalent to approximately 0.40%.

ULTRAVAL SR. TECHNICAL SHEET

- Class cement **CEM I 52,5 R – SR 3** according to the European Standard **UNE-EN 197-1: 2011**, which means that it is composed of portland clinker and gypsum.
- D_{95} equal to 24 microns (allowing the Ultraval SR achieve category microcement).
- Blaine above 7.000 cm^2/g .
- C_3A lower than 3%.
- Na_2O equivalent lower than 0,40%.
- SO_3 lower than 3,2%.
- Cl^- lower than 0,05%.
- Compressive strength at 2 days above 50 MPa**
- Compressive strength at 28 days above 65 MPa**

** Tested according European Standards.





Cementos Portland Valderrivas, S.A. **FÁBRICA: OLAZAGUTIA**
Certificado ER: ER-0878/1987

CERTIFICADO DE CARACTERÍSTICAS TÉCNICAS

Cemento	Periodo
CEM I 52,5R UltraVal SR CEM I 52,5R	enero de 2013 CE: 0099/CPDIA33/0837

ENSAYOS	Resultados Valor Promedio	Especificación Norma ENUNE
Características Químicas		
Pérdida por Calcinación/Pérdida al fuego %	1,6	< 5,0
Residuo Insoluble %	0,2	< 5,0
Sulfatos (SO_3) %	3,0	< 4,0
Cloruros %	0,01	< 0,10
Características Físicas y Mecánicas		
Agua de Consistencia Normal %	37,4	
Principio de Fraguado min	102	> 45
Final de Fraguado min	169	< 720
Expansión Le Chatelier mm	0,5	< 10
Superficie específica (Blaine) cm^2/g	6833	
Resistencia mecánica a compresión a 2 días MPa		
• Media mensual	52,9	> 30,0
• Media acumulada (02/2012 - 01/2013)	49,2	> 30,0
• Desv. Std. acumulada (02/2012 - 01/2013)	2,7	
Resistencia mecánica a compresión a 28 días MPa		
• Media mensual	71,2	> 52,5
• Media acumulada (02/2012 - 01/2013)	74,1	> 52,5
• Desv. Std. acumulada (02/2012 - 01/2013)	2,1	
Características adicionales		
C_3A * (%)	4,1	< 5,0
$C_3A + C_4AF$ * (%)	16,8	< 22,0

* Corresponde a la composición del clinker
El presente documento no implica que por parte de la Empresa se haya suministrado cantidad alguna de cemento

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As previously mentioned, special cements are common cements with some characteristics not specified by the Standards. In the case of microcements are the granulometry and the fulfillment of a number of properties such as stability of the slurry, viscosity, density and setting time.

In the case of MICROVAL TP32, the main features are:

- it is a common cement CEM III B 52.5 N-SR with a 20% of clinker and a 80% of content of blast furnace slag.
- Its name is because TP32 meets the requirement that 95% of the particles are less than 32 microns.



MICROVAL TP32. SPECIAL CHARACTERISTICS

The viscosity values (Marsh cone), decantation, density and setting time are the following:

Rheological and mechanical properties of the slurries

TP - 3 2

C/W	Slurry density	Fluidity ¹ (Marsh cone) (sec.)	Decantation at 3 hours (%) ²	Setting time (hours)	Compressive strength (Mpa)
0,65	1,34	30	3	5	2,5
1,25	1,55	35	3	4	6,5
2,60	1,89	51	0	3	10,0

Tests with 6% additive CPV

¹ Reference value water 27.5 sec.

² In 1 L test-tube.

MICROVAL TP32. TECHNICAL SHEET

- Class cement **CEM III/B 52,5 N-SR 3** according to the European Standard **UNE-EN 197-1: 2011**.
- Core composition:
 - Clinker lower than 30% and blast furnace slag greater than 70%
 - SO₃ lower than 3,0%.
 - Cl - lower than 0,1%.
- D₉₅ equal to 32 microns (the percentage of particles greater than 32 microns is lower than 5%).
- Compressive strength at 2 days greater than 30 MPa **
- Compressive strength at 28 days greater than 65 MPa **

** Tested according European Standards.

Cementos Portland Valderrivas, S.A.

FÁBRICA: OLAZAGUTIA

Certificado ER: ER-08701907

CERTIFICADO DE CARACTERÍSTICAS TÉCNICAS

Cemento

CEM III/B 52,5N MICROVAL TP-32

Periodo

febrero de 2012

CE: 1012/CPDMA33009

ENSAYOS

Características Químicas

Pérdida por Calcinación/Pérdida al fuego	%
Residuo Insoluble	%
Sulfatos (SO ₃)	%
Cloruros	%

Resultados
Valor Promedio

0,6
0,4
2,0
0,03

Especificación
Norma EN/UNE

< 5,0
< 5,0
< 4,0
< 0,10

Características Físicas y Mecánicas

Principio de fraguado	min
Final de fraguado	min
Expansión Le Châtelier	mm
Resistencia mecánica a compresión a 2 días	Mpa
Resistencia mecánica a compresión a 28 días	Mpa

246
297
0,3
25,3
72,8

> 45
< 720
< 10
> 20,0
> 52,5

Curva Granulométrica

Tamiz (µm)

1	%
1,5	%
2	%
3	%
4	%
6	%
8	%
12	%
16	%
24	%
32	%
48	%
64	%
96	%
128	%
196	%
Diámetro a 50%	µm
Blaine	cm ² /g

9,8
13,6
17,8
25,5
32,4
45,4
57,0
75,3
88,0
97,7
99,8
100,0
100,0
100,0
100,0
100,0
6,7
6.788

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Jefe de Control de Calidad

Like the MICROVAL TP32, it is a microcement, and the characteristics not specified by the rules that have to check are its grading and compliance with a number of properties such as slurry stability, viscosity, density and setting time.

In the MICROVAL TP 12 case, the main features are:

- it is a common cement CEM III B 52.5 N-SR with a 20% of clinker and a 80% of content of blast furnace slag.
- Its name is because TP12 meets the requirement that 95% of the particles are less than 12 microns.



MICROVAL TP 12. SPECIAL CHARACTERISTICS

The viscosity values (Marsh cone), decantation, density and setting time are the following:

Rheological and mechanical properties of the slurries

TP - 1 2

C/W	Slurry density	Fluidity ¹ (Marsh cone) (sec.)	Decantation at 3 hours (%) ²	Setting time (hours)	Compressive strength (Mpa)
0,33	1,21	30	7	10	9,0
0,53	1,29	31	2	8	11,5
1,00	1,50	32	2	4	15,5

Tests with 7% additive CPV

¹ Reference value water 27.5 sec.

² In 1 L test-tube.

MICROVAL TP 12. TECHNICAL SHEET

- Class cement **CEM III/B 52,5 N-SR** according to the European Standard **UNE-EN 197-1: 2011**.
- Core composition:
 - Clinker lower than 30% and blast furnace slag greater than 70%.
 - SO_3 lower than 3,0%.
 - Cl^- lower than 0,1%.
- D_{95} equal to 12 microns (the percentage of particles greater than 12 microns is lower than 5%).
- Compressive strength at 2 days greater than 30 MPa **
- Compressive strength at 28 days greater than 70 MPa **

** Tested according European Standards.








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Certificado ER: ER-0879/1997

CERTIFICADO DE CARACTERÍSTICAS TÉCNICAS

Cemento:
CEM III/B 52,5N MICROVAL TP-12
CE: 1012/CPDIA33008

Periodo:
abril de 2012

ENSAYOS	Resultados Valor Promedio	Especificación Norma ENCE
Características Químicas		
Pérdida por Calcinación/Pérdida al fuego %	0,9	< 5,0
Residuo Insoluble %	0,4	< 5,0
Sulfatos (SO_3) %	3,1	< 4,0
Cloruros %	0,03	< 0,10
Características Físicas y Mecánicas		
Principio de fraguado min	196	> 45
Final de fraguado min	249	< 720
Expansión Le Chatelier mm	0,2	< 10
Resistencia mecánica a compresión a 2 días Mpa	40,3	> 20,0
Resistencia mecánica a compresión a 28 días Mpa	79,0	> 52,5
Curva Granulométrica		
Tamiz (μm)		
1 %	24,4	
1,5 %	31,0	
2 %	38,7	
3 %	53,7	
4 %	65,5	
6 %	81,2	
8 %	90,3	
12 %	98,1	
16 %	99,9	
24 %	100,0	
32 %	100,0	
48 %	100,0	
64 %	100,0	
96 %	100,0	
128 %	100,0	
196 %	100,0	
Dámetro a 50% μm	2,7	
Bulne cm^3/g	11,945	

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RAPIDVAL is a **natural cement with a fast setting time and hardening**. Its composition has the usual components of Portland clinker, although in different proportions.

This characteristic mix is the basis for an extremely useful product in the world of construction, that achieves setting times in 4-5 minutes, reaching initial resistances in only 15 minutes, enough to perform most of the works in its scope.

Características físicas y mecánicas:

- ✓ Blaine higher than 6000 cm²/g
- ✓ Final setting time lower than 3 minutes.
- ✓ Compressive strength of a cement-sand mixture in a 1/2 ratio (one cement/two sand) with 0.4 water/cement ratio:
 - To 15 minutes, greater than 1,5 Mpa.
 - To 28 days, greater than 25 MPa.

RAPIDVAL. APPLICATION EXAMPLE



Very useful cement for small jobs that requiring hardening very fast

6 MONTHS LATER



C.I.T. SPECIAL CEMENTS IN CONCRETE FOR TUNNELING AND MINING

INTRODUCTION

The contribution that the use of Special Cements developed by CEMENT INTERNATIONAL TECHNOLOGIES give to the manufacture of concrete for tunneling and mining can be summarized under the following headings:

- Profits from its use.
- Concretes with easily controllable workability time.
- Concretes with very fast development of early mechanical strengths.
- Concretes with high final mechanical strengths.



PROFITS FROM ITS USE

Special cements of CEMENT INTERNATIONAL TECHNOLOGIES allows very high performances in a few hours which means significant savings due to:

- **New construction designs.** High performance concrete economical and simple way in the work itself are achieved.
- **New organization in the execution of the work.** Concrete benefits are achieved with mold release and service in a few hours.
- **Higher production rates.** Putting into service of high performance concrete in a few hours (even below 5 hours).
- **High performance self-compacting concrete** and therefore easy and fast spread.
- **Substitution**, with important advantages, **other more expensive materials** such as microsilica or calcium aluminate cement.

and all this with a **flexible technology** that allows, for every situation, a **blend of a percentage of local cements with Special Cements** to achieve the necessary results.

WORKABILITY TIME EASILY CONTROLLABLE

The high-strength concrete, especially when these are required in a few hours, often have serious problems of workability with high risks.

The workability control in the Special Cements of CEMENT INTERNATIONAL TECHNOLOGIES is very simple and does not affect the initial and final strengths.

In the attached graph, relating to the tests carried out in a concrete plant in Peru, it is seen as the workability of a concrete with a mixture of 40% local cement and 60% ULTRAVAL, and other concrete with 100 % ULTRAVAL, remains constant for 4 hours, with a cone of 25 cm (self compacting), and reaches very high strengths at 11 hours, five after missing workability.

Fecha	18/11/2015		18/11/2015	
PRUEBAS DE COMBINACIÓN DE CEMENTOS	FC 420 H67 6"-8"		FC 420 H67 6"-8"	
	NACIONAL 40% ULTRAVAL 60%		ULTRAVAL 100%	
Insumos PESOS SSS	DE - 877		DE - 878	
Cemento	180		0	
ULTRAVAL	270		450	
Agua	185		191	
TM 30	1.35		1.58	
% TM 30	0.30%		0.35%	
VISC. SC50	4.95		5.40	
% VISC. SC50	1.10%		1.20%	
% Arena	47.0%		47.0%	
% Piedra	53.0%		53.0%	
A/C	0.411		0.424	
Temperatura agregado fino	20.8		20.8	
Temperatura agregado grueso	20.6		20.6	
Temperatura Cemento	24.6		24.6	
% Contenido Aire	1.6%		1.2%	
	SLUMP		SLUMP	
	Slump	T °C	Slump	T °C
0	24.5	25.6	24.5	25.7
30	26.0	24.7	26.0	24.8
90	26.0	23.7	25.5	23.7
150	26.0	22.9	25.5	23.4
210	25.5	22.1	25.0	22.4
240	24.5	22.0	24.5	22.5
	RESISTENCIA		RESISTENCIA	
	Resist.	Prom.	Resist.	Prom.
fc 11 HORAS (kg/cm ²)	24	25	115	114
	25		113	
	0	127%	0	27%
fc 14 HORAS (kg/cm ²)	528	532	492	505
	535		517	
	0	127%	0	120%
fc 17 HORAS (kg/cm ²)	528	532	547	543
	535		539	
	0	127%	0	129%
fc 24 HORAS (kg/cm ²)	528	532	627	629
	535		631	
	0	127%	0	150%

WORKABILITY TIME EASILY CONTROLLABLE

The high efficiency of the Special Cement with additives allows:

- a water/cement ratio lower than common cements,
- easily controllable periods of workability, and
- high resistance five hours after missing the workability due to start tightening.

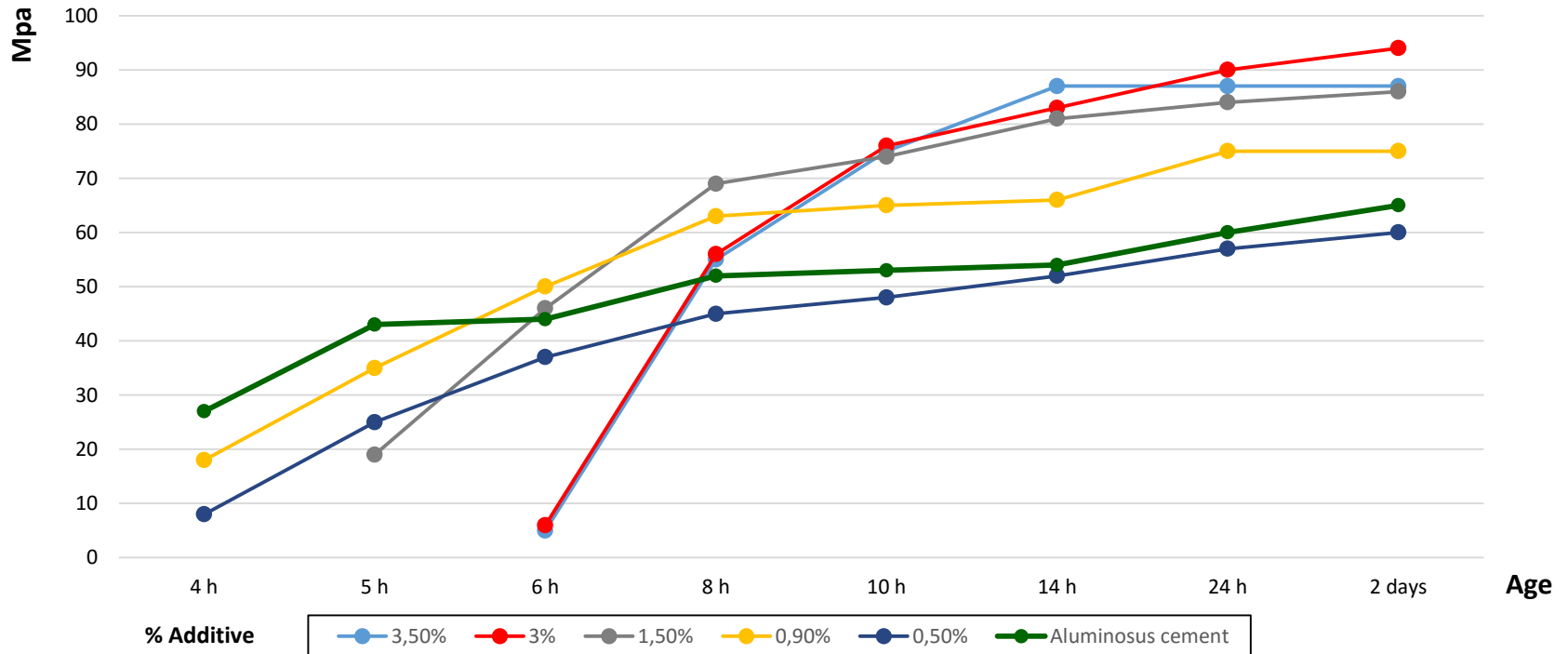
If high workability periods are not required, you can reduce the water, obtained before the resistances, and being these higher.

Often with a percentage of 10% mixture of Special Cement with a local cement is enough to achieve the necessary goals, with the possibility of increase that percentage where the requirements are higher.

The ULTRAVAL and ULTRAVAL SR cements are big activators of pozzolans, fly ash, blast furnace slag and silica fume, getting his almost complete activation within days. With other cements it would take about 90 days to do the same. This is an important property for the concrete design effectively and efficiently.

VERY FAST DEVELOPMENT OF EARLY STRENGTHS

Special cements, ULTRAVAL and ULTRAVAL SR, for its mineralogical composition and particle size distribution curve, allows very high initial resistance (even greater than aluminous cement, as you can see in the accompanying chart).



HIGH FINAL MECHANICAL STRENGTHS

All CEMENT INTERNATIONAL TECHNOLOGIES special cements, for its mineralogical composition and particle size distribution curve, allows very high final strengths.

The Special Cement selection should be done according to the benefits they want to achieve. Thus, it will be used:

- ULTRAVAL, if high initial and final strength are needed.
- ULTRAVAL SR, if high initial and final resistance sulfates or marine environments is required.
- MICROVAL TP32 or MICROVAL TP12, if high initial and final resistance in environments with sulfate, marine, or weakly acidic or weakly pure water is needed.

SPECIAL CEMENTS ADVANTAGES IN TUNNELING AND MINING

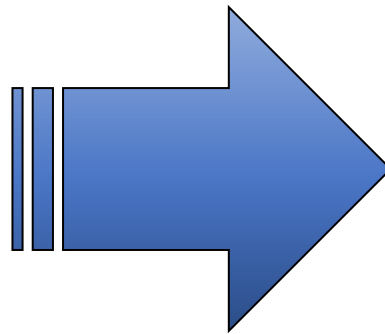
The ULTRAVAL and ULTRAVAL SR cements are the fastest on the market to develop concrete strengths, shotcrete in this case, with the following advantages:

- **Workability time constant and controlled at will resulting** in a stable operation and in a shotcrete constant quality.
- For its efficiency with the additives, especially polycarboxylates, it creates a viscous concrete with **less bounce and less hollows**.



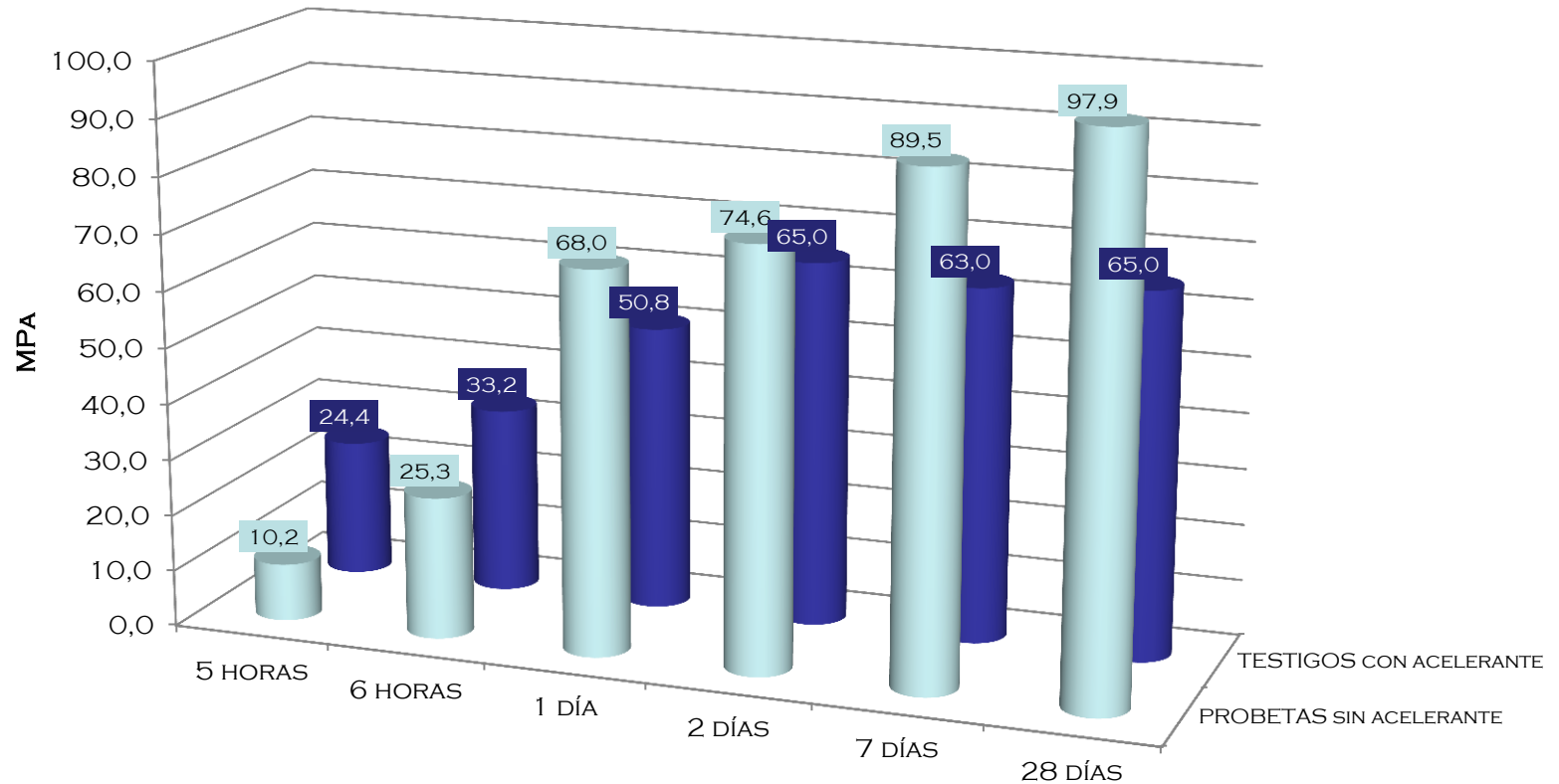
- For its mineralogical composition and particle size allow **easily achieve J3 shotcrete curve** and get in **5 hours over 20 Mpa**.
- Therefore, **less reliance on the expertise of the applicator**, fewer defects and therefore better mechanical strength.

- Decreases up to 40% the amount of accelerant.
- The **substitution of microsilica** in the shotcrete by ULTRAVAL or ULTRAVAL SR **improves its viscosity**, decreases the rebound and **increases the initial and final strengths**.



Obtaining witnesses from troughs. "Witnesses with accelerant"

SHOTCRETE. RESISTANCES EVOLUTION



Blending type used in tests

HIGH PERFORMANCE SHOTCRETE I

FCC

Vergara Tunnel. Guipúzcoa (España)



Target:

- 60 Mpa at 28 days.

C.I.T.



UltraVal 

Results:

- Compressive Strength of 65 MPa at 24 hours with less cement content.
- Reduction in volume of concrete required due to the high initial and final strengths.

HIGH PERFORMANCE SHOTCRETE II

FCC

Vacariza-Rialiño Tunnel. La Coruña (España)

- Railway tunnel.
- Austrian excavation method.
- Shotcrete required characteristic strength of 30 Mpa.

C.I.T.



UltraVal 

- Design strengths reached in a few hours.
- Correct strengths in concrete with metal fibers and/or polyolefin fiber.
- Projection with a reasonable rejection.
- Low percentage of accelerating additive.
- Increases security during the galleries drilling.



HIGH PERFORMANCE SHOTCRETE III

FCC

Sant Hilari Tunnel. Gerona (España)



Target:

- Evaluate shotcrete performance.

C.I.T.



UltraVal 

Strengths at early ages	Penetration test	Trough	1.3 MPa strength: - UltraVal at 1,08 minutes - Standard at 26.25 minutes
		Coating	1.3 MPa strength: - UltraVal at 12,22 minutes - Standard at 23.25 minutes
	Bended clove	Trough	R 24h with Ultraval: 37.5% higher than the standard
		Coating	R 24h with Ultraval: 15.0% higher than the standard
28 day strength			In Ultraval, 40% greater than the standard
indirect traction strength			In Ultraval, 20% greater than the standard
Quantification Rebound			% lower in UltraVal

The ULTRAVAL and ULTRAVAL SR cements are the fastest on the market by developing concrete strengths. For coatings tunnels with shotcrete are also obtained the following advantages:

- **Workability time constant, controlled at will**, resulting in stable operation and constant quality shotcrete.
- For its efficiency with the additives, especially polycarboxylates, **concretes with a water/cement very low**, low permeability and high durability are achieved.
- Mineralogical composition and granulometry allows obtaining concretes **over 50 MPa in less than 5 hours** after kneading or from the loss of workability.
- The above allows **a threefold increase productivity** (carriage movements in 8 hours instead of 24 hours).
- **Microsilica replacement** in high-strength concrete by the same percentages of ULTRAVAL SR or ULTRAVAL **improves initial and final mechanical strength** and efficiency with additives, especially polycarboxylates, **with an important saving**.



TUNNEL COVERS (SHUTTERING CARS)

FCC

Ordízia Tunnel. Guipúzcoa (España)

- Tunnel railway covering.
- Initial performance:
 - 5 carriages weekly
 - Rhythm concrete 40 m³/h
 - Execution period 13 weeks.
- Search productivity improvements.

C.I.T.



UltraVal 

- Concrete strengths to demoulding gotten in 3.5 to 4 h
- Final performance:
 - 10 carriages weekly
 - Rhythm concrete 80 m³/h.
 - Execution period 8 weeks.



UNDERGROUND CONSTRUCTION

FCC

Sorbas Tunnel. Almería (España)



Target:

- 110 Mpa in 28 days.

C.I.T. ↓ UltraVal 

Result:

- 110 MPa in two days, with lower cement content without special additions (silica fume)

CONSTRUCTION AND REPAIRS OF PAVEMENTS

In mining or in a tunnel, the construction of pavements in record time allows increased operational performance due to increase the speed of trucks traffic transporting mineral, excavation materials, concrete, shotcrete, etc.

Paving with ULTRAVAL and ULTRAVAL SR, or mixtures of these cements with local cements, allows put into service the pavements in less than 6 hours with flexural strength greater than 4,5 MPa.



CONSTRUCTION AND REPAIRS OF PAVEMENTS

FCC

Ordicia and Bergara Tunnel AVE. Guipúzcoa (España)



Target:

- 4.5 MPa of flexural strength at 8h.

C.I.T. ↓ UltraVal 

Result:

- 4.5 MPa of flexural strength and 40 MPa of compressive strength in 6 hours.
- Quick opening to traffic of trucks.

CONSTRUCTION AND REPAIRS OF PAVEMENTS

FCC

Access to the toll tunnel. Envalira (Andorra)

Concrete pavement with severe surface damage.

Target:

- Minimize the impact on traffic rehabilitation operations.

C.I.T. ↓ UltraVal 

Result:

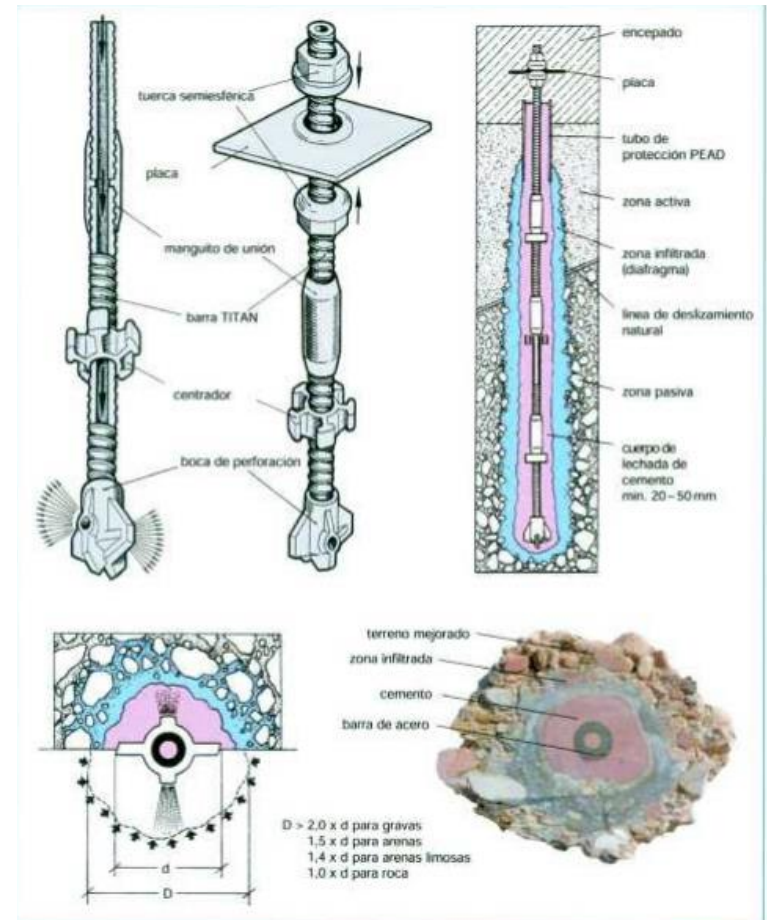
- Quick opening to traffic (less than 6 hours).



BOLTS AND ANCHORS

Bolts and anchors made by injecting slurries with ULTRAVAL or ULTRAVAL SR can be put into service in a few hours.

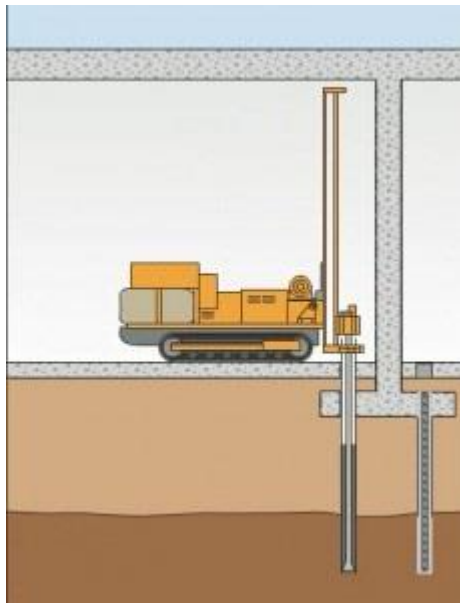
It can also be used for these purposes slurries with MICROVAL TP32 or MICROVAL TP12.



MICROPILES

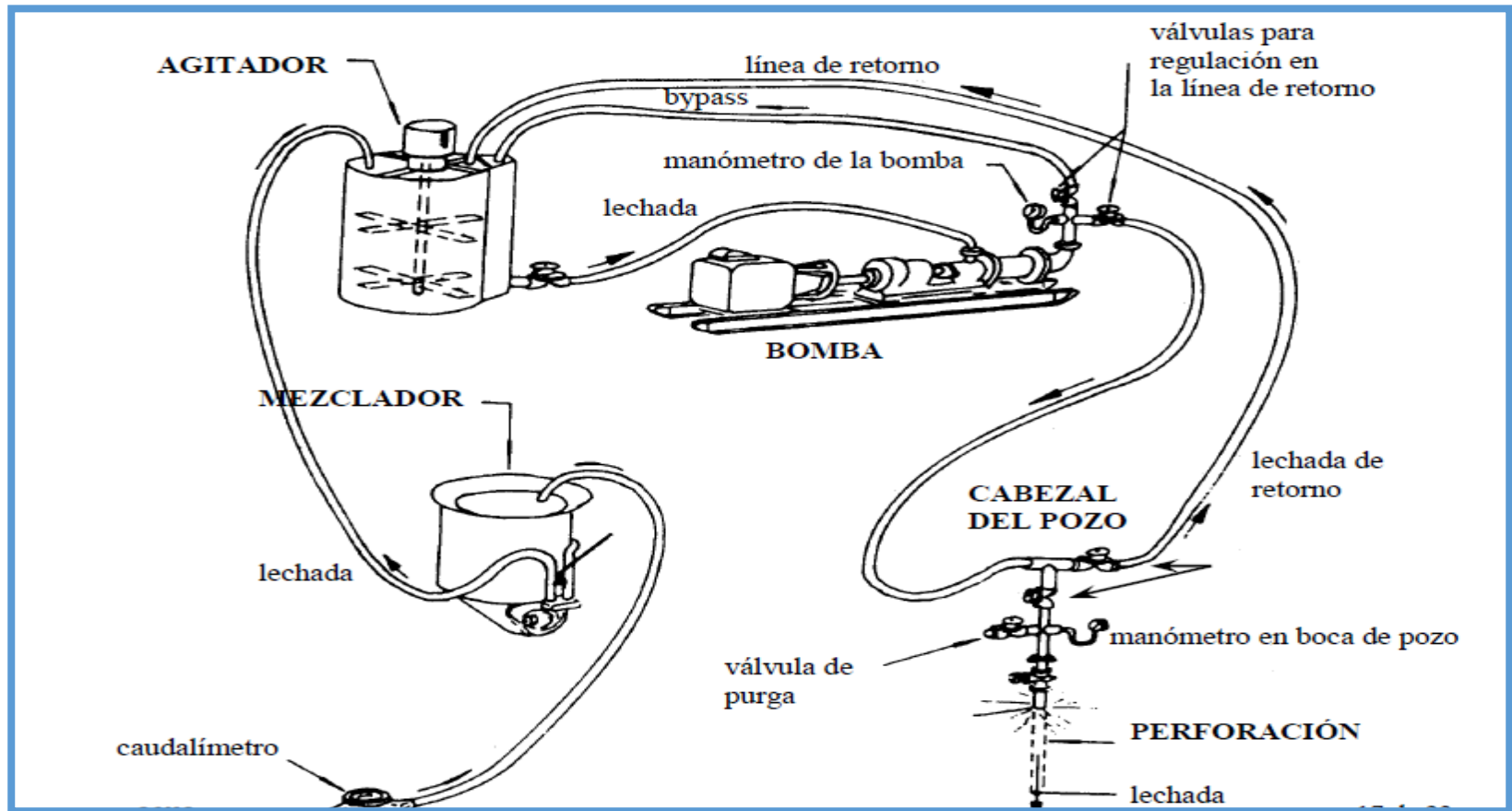
Micropiles made by injecting slurries with ULTRAVAL or ULTRAVAL SR can be put into service in a few hours.

It can also be used for these purposes slurries with MICROVAL TP32 or MICROVAL TP 12.



All these cements (microcements) meet regulatory requirements for these purposes, including mechanical strength and decantation.

MICROCEMENTS INJECTIONS



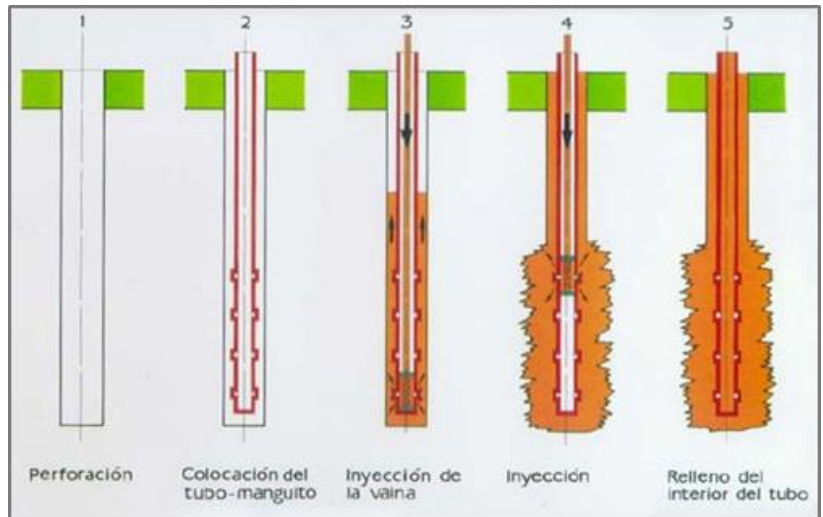
Pre-injection and post-injection in underground constructions and land mining

MICROCEMENTS INJECTIONS. OBJECTIVES I

Microcements injections under pressure comprises the pressure injection of a liquid (slurry) or suspension in the empty soil or rock mass (discontinuities) or contact between these materials and existing structures.

The microcements injections objectives are:

- I. Permeability reduction**
- II. Improvement of the mechanical properties of medium**
- III. Filling soil voids**
- IV. Stabilization**



MICROCEMENTS INJECTIONS. OBJECTIVES II

I. Permeability reduction

The permeability reduction obtained with injection improves:

- The reduction of hydrostatic forces acting on the base structures or in covers of tunnels.
- Reduction of water losses from a reservoir.
- Inhibition of internal erosion of the foundation and body materials of dams.
- Improved digging conditions for stabilization, consolidation and/or water control.

In the above structural safety applications involving injections they should not be considered as the only defense and it must be combined with drains, anchors, reinforcements, etc.

II. Improvement of the mechanical properties of medium

The microcements injections:

- Increase the bearing capacity of the injected medium.
- Generates the consolidation of highly fractured rocks and facilitate excavation work.

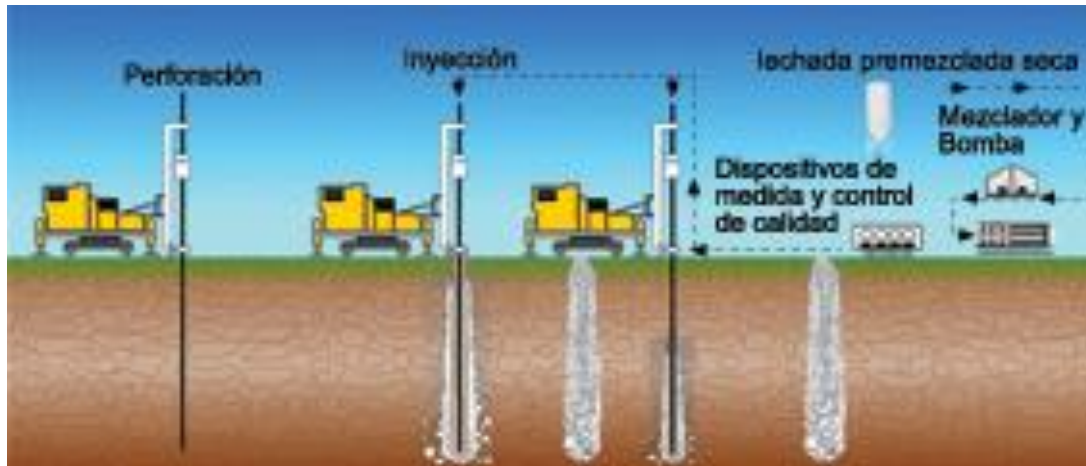
MICROCEMENTS INJECTIONS. OBJECTIVES III

III. Filling soil voids

The microcement injections may be necessary for filling of both ,surface and deep voids.

IV. Stabilization

The microcement injections are used for the stabilization of foundations, slabs and pavements.



MICROCEMENTS INJECTIONS. CHARACTERISTICS

With ULTRAVAL and ULTRAVAL SR microcements, very fast portland cements, uninterrupted sequences of blasting and continued injection sequences are achieved.

They are very suitable for injections at **very low temperatures**.

If used with accelerators can clog cracks with important water flows, immediately.



At normal or high temperatures, or when it is not necessary very fast setting and hardening, the MICROVAL TP32 or MICROVAL TP12 are advised for their more open setting time and leaching durability.



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SUSTAINABLE CEMENTS WITH PERSONALIZED ADVICE