

COMPARATIVE STUDY OF FRENCH AND YUGOSLAV  
RADIOACTIVE WASTE FORMS

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ABSTRACT

Low and intermediate level radioactive waste represents 90% of total radioactive waste. It is conditioned either into metal barrels, or into special concrete containers. Since these concrete containers are to protect safely the radioactive waste for around 300 years, the selection of materials and precise control of their physical and mechanical characteristics is very important.

In this work, results obtained with some French and Yugoslav concrete compositions are compared. These compositions will be recommended for concrete containers for future Yugoslav radioactive waste storing center.

MATERIALS

French Materials

Cement CPA-50Q, produced in France was used. Sand from Bayeux, fraction 0-5 mm, was used. Crushed quarcite from the Brix quarry (Manche) was used in two size fractions: 3-6 mm and 10-14 mm. The water used for preparation of concrete was in accordance with the AFNOR-P 18-303 standard and there was no more than 0,002 kg/l of suspended particles in it. Additive "LL-923", produced in France, was used.

Yugoslav Materials

Cement CPA-55 MPa, produced in Yugoslavia (Beočin Cement factory) was used. Sand "Moravac" from Serbia, fraction 0-2 mm, was used. Gravel "Moravac" was used in the three following fractions: 2-4 mm, 4-8 mm and 8-15 mm. The water used for preparation of concrete was in accordance with the YU standard, and there was no more than 0,002 kg/l of suspended particles in it. Plastificator type additives, produced in Yugoslavia ("CHROMOS"-factory Zagreb): "Super Fluidal" and "Fluidal VX-OC" were used.

CONCRETE COMPOSITION FOR CONTAINERS

Concrete Composition for Containers Manufactured from French Materials

FORMULA I  
(composition referred to 1 m<sup>3</sup> of concrete)

CPA-55	400 kg
Sand "Bayeux"	475 kg
Brix 3-6 mm	275 kg
Brix 10-14 mm	1235 kg
Water	130 l
"LL-923" 2%	8 l

FORMULA II

CPA-55	400 kg
Sand "Bayeux"	525 kg
Brix 3-6 mm	475 kg
Brix 10-14 mm	935 kg
Water	130 l
"LL-923" 2%	8 l

Concrete Composition for Containers Manufactured from Yugoslav Materials

FORMULA III

CPA-55 MPa	400 kg
Sand "Moravac" 0-2 mm	625 kg
Gravel 2-4 mm	69 kg
Gravel 4-8 mm	496 kg
Gravel 8-15 mm	794 kg
Water	140 l
"Super Fluidal"	4 l

FORMULA IV

CPA-55 MPa	400 kg
Sand "Moravac" 0-2 mm	625 kg
Gravel 2-4 mm	69 kg
Gravel 4-8 mm	496 kg
Gravel 8-15 mm	794 kg
Water	140 l
"Fluidal VX-OC"	1,5 l

WORKABILITY MEASUREMENT, WEIGHT LOSS, SHRINKAGE, BENDING STRENGTH, COMPRESSIVE STRENGTH AND PERMEABILITY

The following characteristics were systematically measured after 1,7 and 14 days.

- weight loss
- shrinkage

and after 28 days

- weight loss
- shrinkage
- bending strength
- compressive strength
- nitrogen permeability of concrete(Fig.1.)

The results are shown in the following paragraphs.

RESULTS

TABLE I SLUMPTEST (cm)

FORMULA	I	II	III	IV
Slump of the samples	0,5	0,6	0,6	0,7

TABLE II WEIGHT LOSS (kg/m<sup>3</sup>)

FORMULA	7 days	14 days	28 days
I	20	21	21
II	23	30	30
III	23	32	34
IV	22	33	34

TABLE III SHRINKAGE ( $\mu\text{m}/\text{m}$ )

FORMULA	7 days	14 days	28 days
I	133	163	216
II	290	350	353
III	280	340	358
IV	200	220	272

TABLE IV BENDING STRENGTH (MPa)  
(concrete samples prism 7x7x28 cm)

FORMULA	28 days
I	5,8
II	5,7
III	-
IV	-

TABLE V COMPRESSIVE STRENGTH (MPa)

FORMULA	28 days
I	69,8
II	67,6
concrete samples cube (10x10x10 cm)	
III	54,4
IV	48,8

TABLE VI NITROGEN PERMEABILITY (m<sup>2</sup>)<sup>a)</sup>  
(concrete samples cylinder  $\phi$  11 cm, H=11cm)

FORMULA	28 days
I	$4,52 \cdot 10^{-16}$
II	$2,20 \cdot 10^{-16}$
III	$8,20 \cdot 10^{-18}$
IV	$2,08 \cdot 10^{-17}$

## CONCLUSION

Analysis of these results has shown the similarity of rheological properties of French and Yugoslav concretes.

The French formulas have a slight advantage regarding the physical and mechanical characteristics, while the Yugoslav ones have somewhat better permeability characteristics.

Except shrinkage, characteristics of "Super Fluidal" are better, especially regarding nitrogen permeability.

a)  $1 \text{ m}^2 = 10^{12} \text{ Darcy}$ 

On the basis of these results, it is possible to recommend FORMULA III for concrete containers for final storage of radioactive waste in future Yugoslav storing center.

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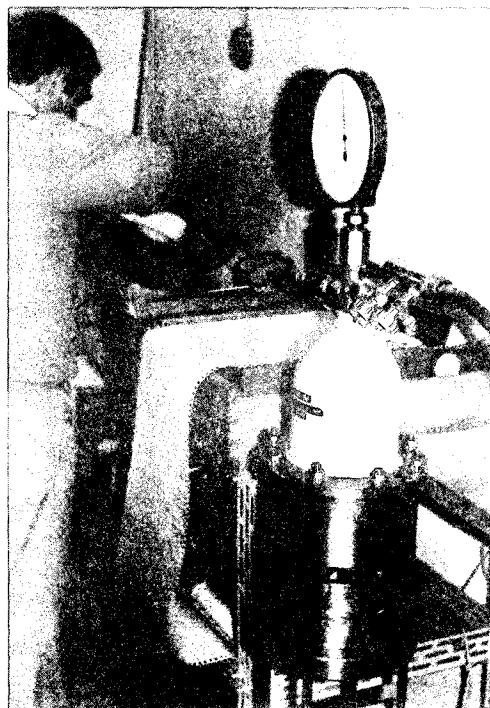


Fig.1. Apparatus for permeability measurement