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REUSE OF SEWAGE SLUDGE – PROBLEMS AND POSSIBILITIES

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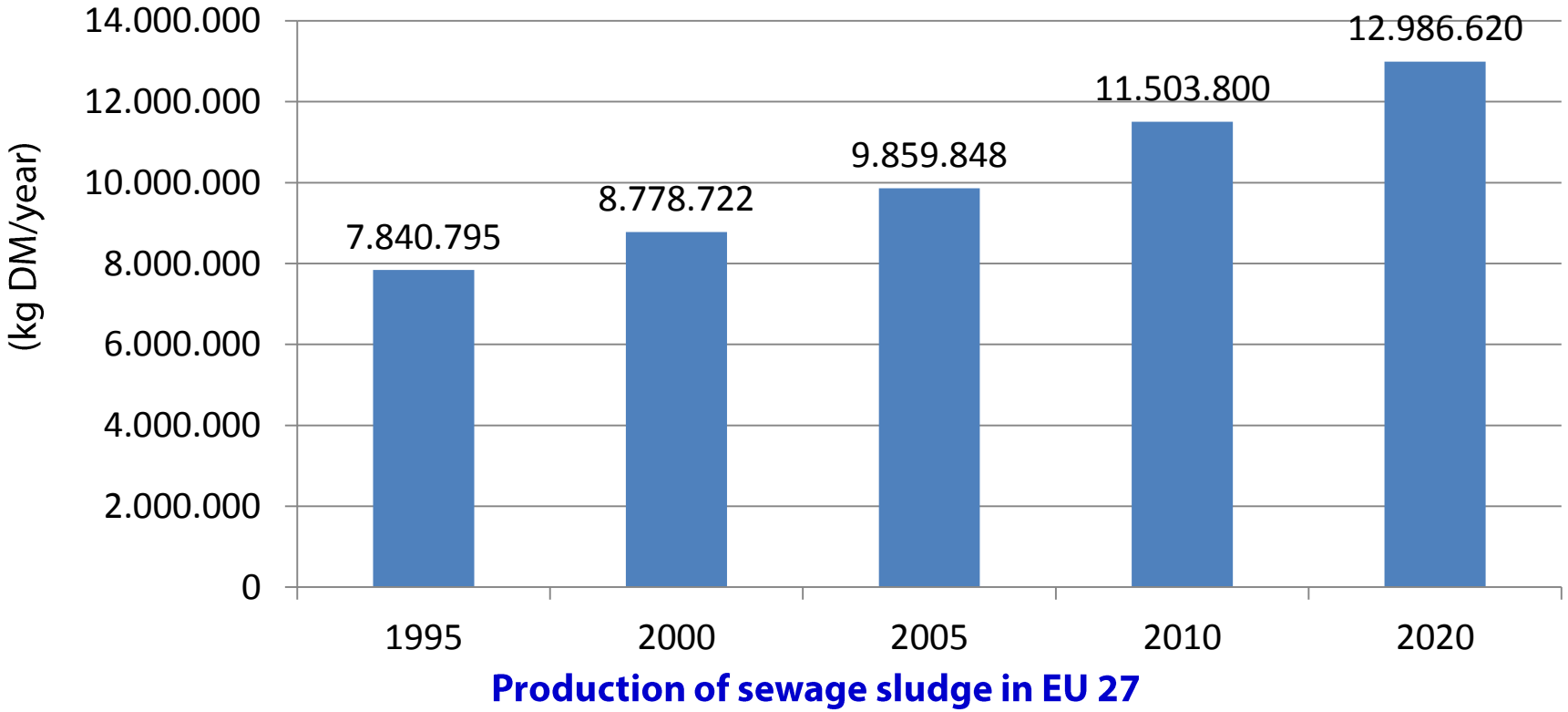
Each stage of wastewater treatment generates certain quantities of sewage sludge that need to be adequately treated at wastewater treatment plants and disposed of in the environment.

(0,5 kg sludge / m^3 wastewater)

(50-70 g DM / PE d)

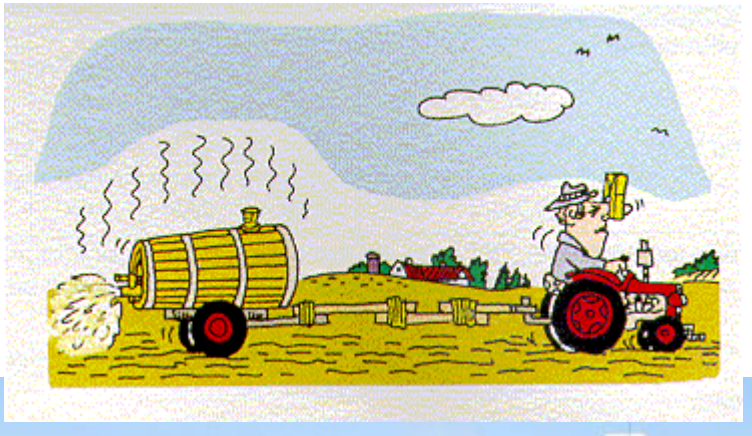
Costs of sewage sludge treatment and disposal are not negligible, and in WWTP sized from 5,000 to 200,000 PE they amount to approximately 50% of total operating costs, and in certain circumstances they can be considerably higher, with increased negative sociological impact.

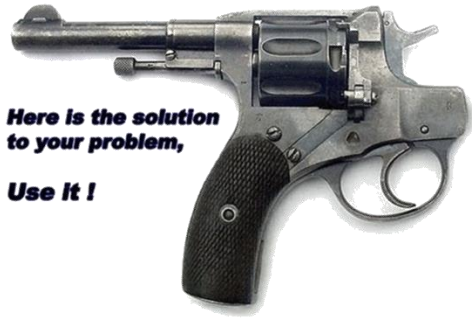
As construction of WWTP is becoming more intensive on a worldwide level, sludge disposal will become a burden to many water utilities, and more and more sewage sludge is produced each year



Production of sewage sludge in EU 27

There are many options for sludge treatment and disposal.





WWTP

WASTEWATER
(120.000.000 m^3/year)

SYSTEM CAPACITY
(1.500.000 PE)

STABILIZED AND DEWATERED SLUDGE
(80.000 tons/year)

SLUDGE INCINERATION
(80.000 tons/year)

SEWAGE SLUDGE ASH - ISSA
(18.000 tons/year)

EU Directive 91/271/EEC: *„Sustainable sludge handling may be defined as a method that meets requirements of efficient recycling of resources without supply of harmful substances to humans or the environment".*

The possibility of reuse of sewage sludge (ISSA) greatly depends on its composition, mainly chemical.

The present worldwide practice offers several possible solutions of reuse of sewage sludge ash (ISSA):

1. **Use in agriculture**
2. **Phosphorus extraction**
3. **Use in construction**
   - **Soil improvement**
   - **Road construction**
   - **In production of bricks**
   - **In concrete industry (production of concrete, concrete elements, cement mortars, etc.)**

CHARACTERISTICS OF ISSA:

- **Chemical composition (Si, Ca, Fe, Al, P, less portion of heavy metals)**

	Oxide percentage in ISSA [%]		
Oxide	Range (literature review)	WWTP Karlovac, CRO 800 °C	WWTP Koprivnica, CRO 800 °C
SO_3	0.24 – 12.40	5.83 – 7.66	1.15 – 1.40
Fe_2O_3	4.70 – 20.00	8.21 – 9.46	0.31 – 0.40
SiO_2	17.27 – 50.60	2.87 – 7.94	0.41 – 0.49
CaO	1.93 – 31.30	37.64 – 42.12	92.82 – 93.83
MgO	1.40 – 3.22	4.23 – 4.53	0.71 – 0.77
Al_2O_3	6.32 – 19.09	11.72 – 16.46	0.89 – 1.19
P_2O_5	1.67 – 18.17	16.02 – 17.21	0.80 – 0.83
TiO_2	0.29 – 1.00	0.76 – 1.03	0.04 – 0.05
Na_2O	0.32 – 1.26	0.28	0.03 – 0.04
K_2O	0.62 – 2.34	1.26 – 1.31	0.12 – 0.13

EXPERIMENTAL RESEARCH:

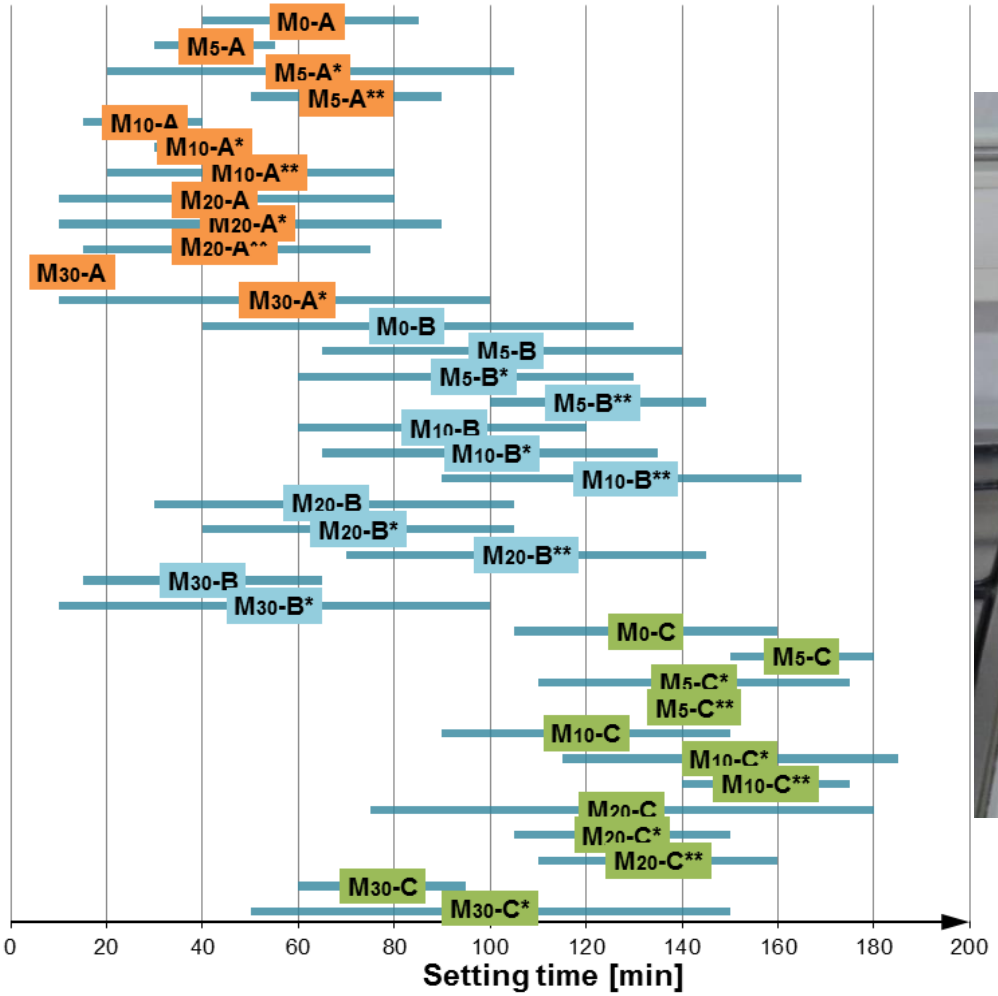
- Testing of the effect of incorporation of ISSA on properties of cement mortar in fresh and hardened condition,
- The ISSA was obtained by incineration of stabilized and dewatered sludge from WWTP Karlovac in Croatia of up to 100.000 PE,
- The plant includes the third stage of treatment.

Cement mortar mixtures:

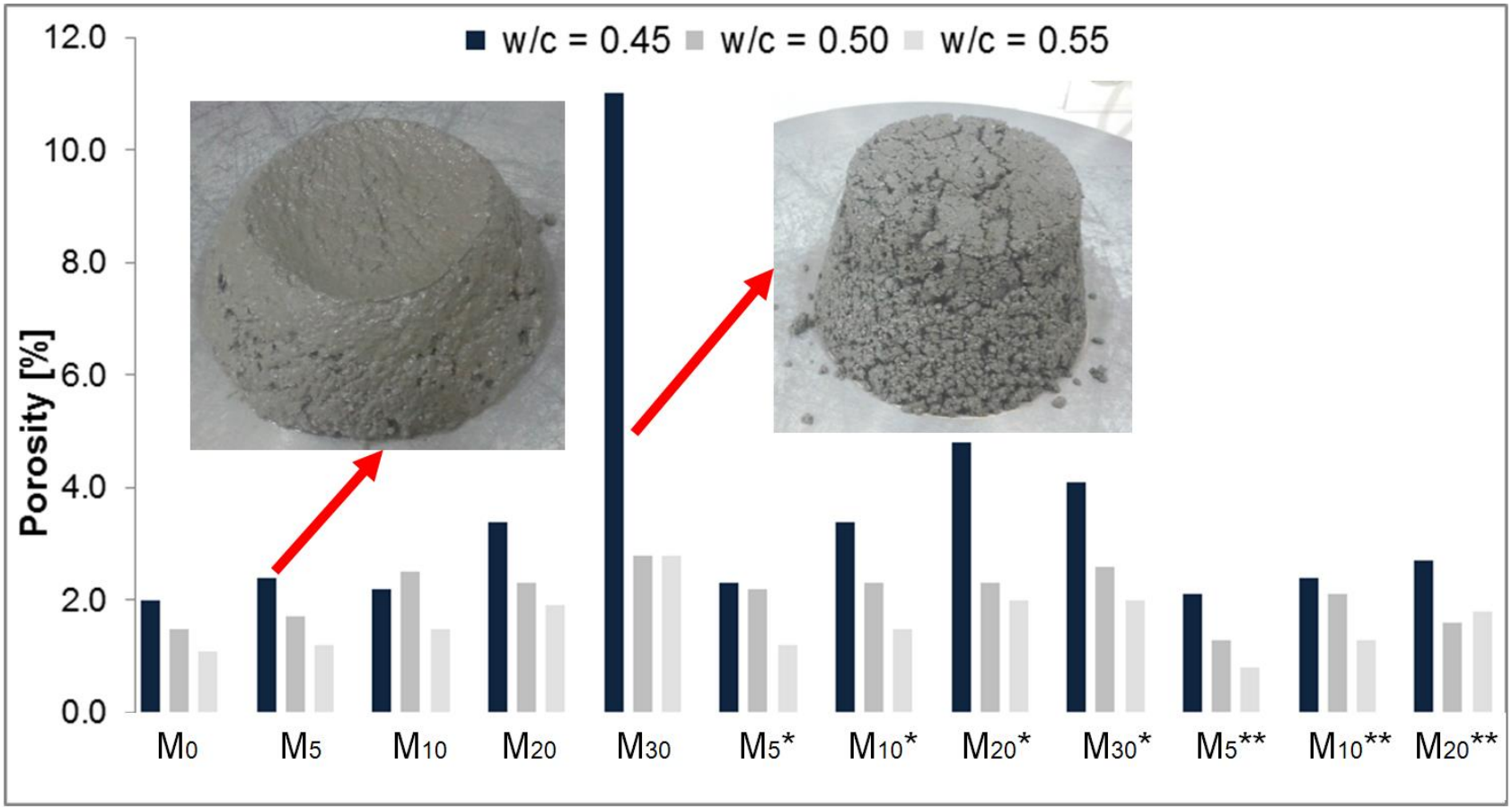
Mixture	ISSA share [%]	w/c ratio	Incineration temperature	Mixture	ISSA share [%]	w/c ratio	Incineration temperature
M_0 - A	0	0.45	-	M_{10} – C	10	0.55	800 °C
M_0 - B	0	0.50	-	M_{20} – A	20	0.45	800 °C
M_0 - C	0	0.55	-	M_{20} – B	20	0.50	800 °C
M_5 – A	5	0.45	800 °C	M_{20} – C	20	0.55	800 °C
M_5 – B	5	0.50	800 °C	M_{30} – A	30	0.45	800 °C
M_5 – C	5	0.55	800 °C	M_{30} – B	30	0.50	800 °C
M_{10} – A	10	0.45	800 °C	M_{30} – C	30	0.55	800 °C
M_{10} – B	10	0.50	800 °C	M_5 – A*; M_{20} – C**			

Note: * mixtures with ISSA incinerated at 900 °C
** mixtures with ISSA incinerated at 1000 °C

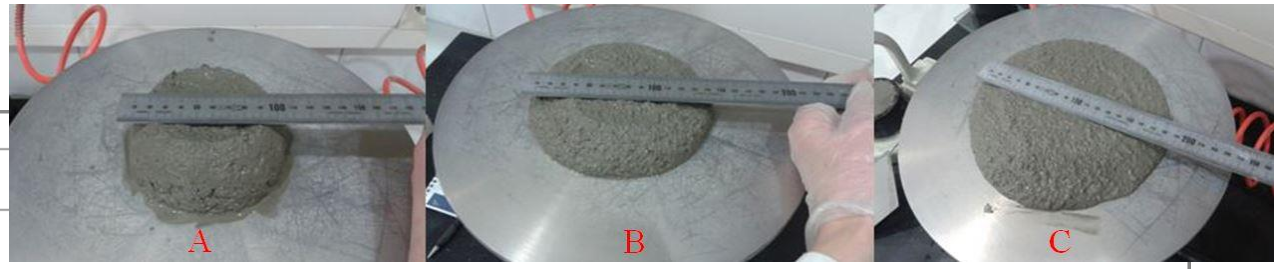
Setting time

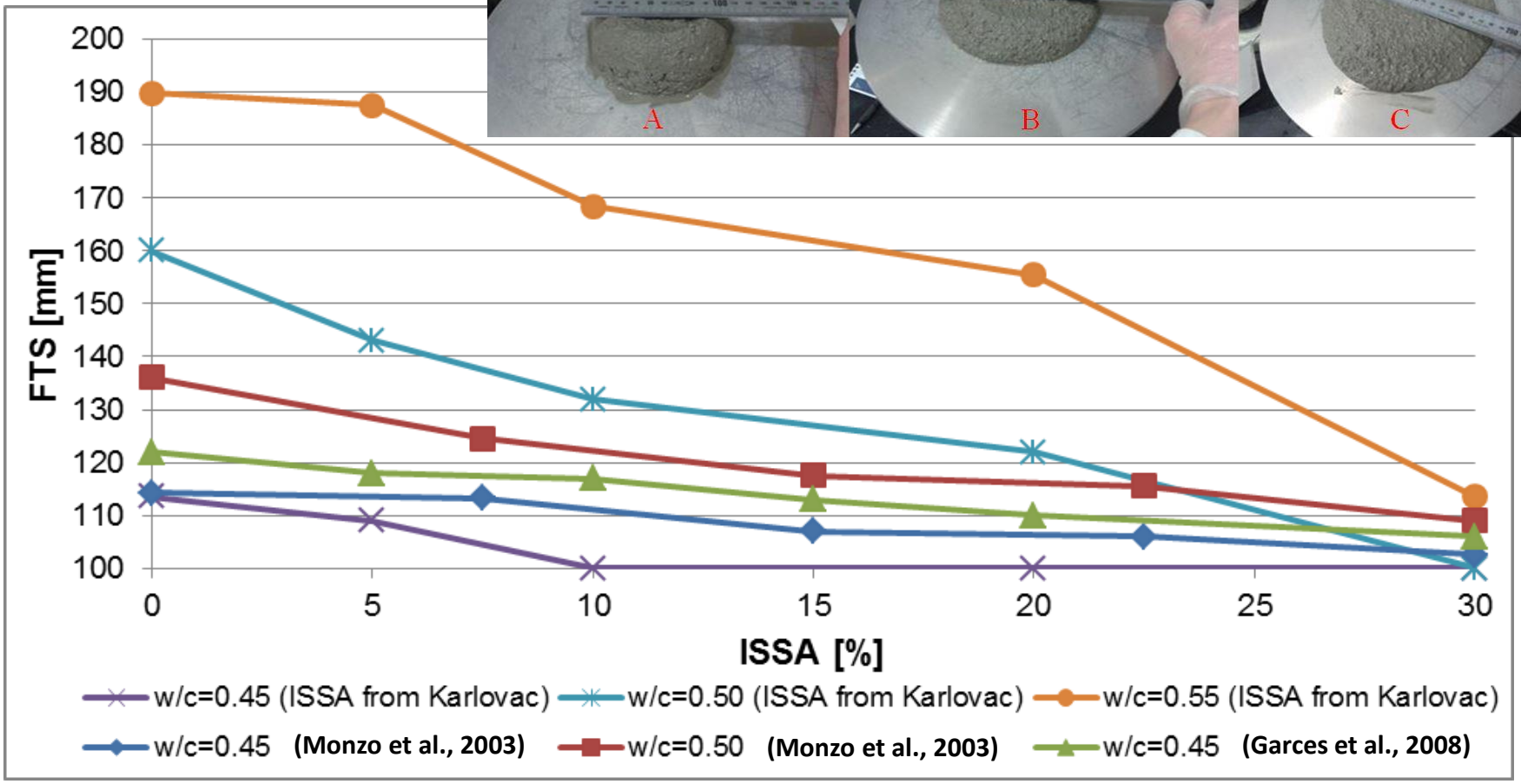


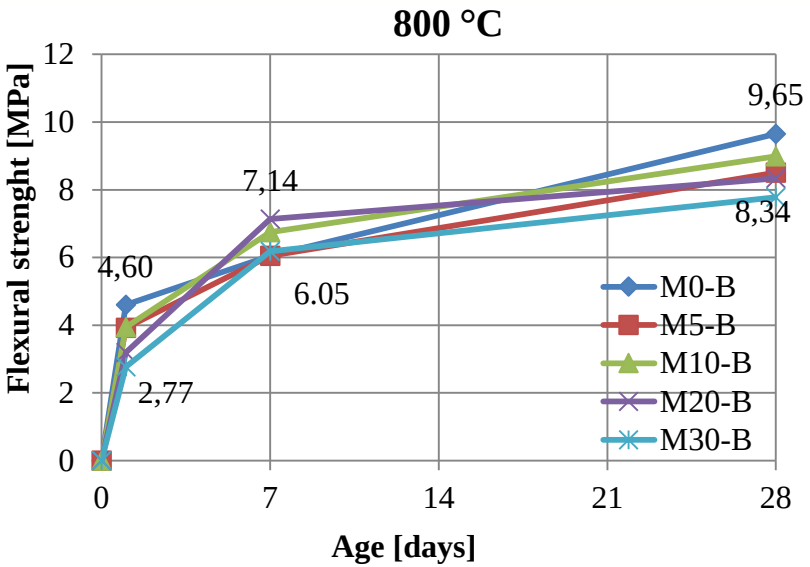
Porosity

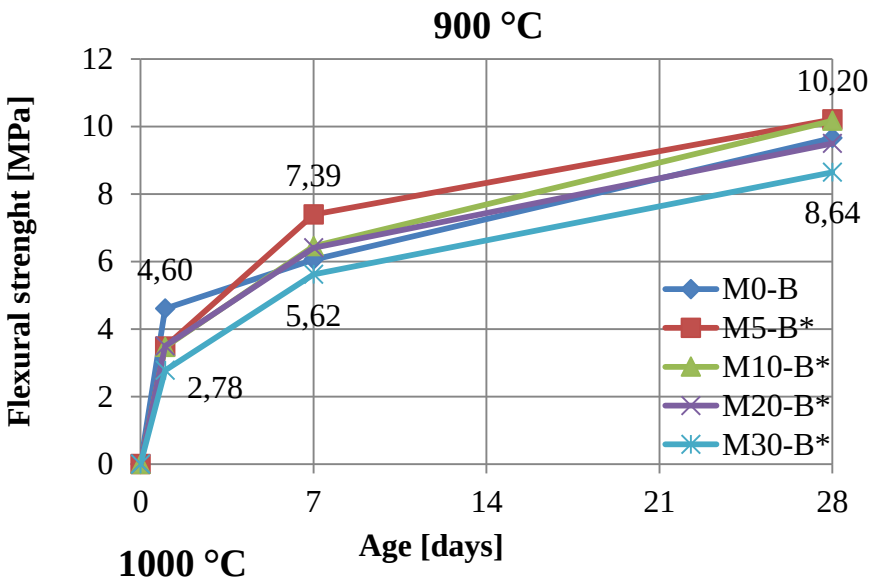

w/c = 0.45
w/c = 0.50
w/c = 0.55
Porosity [%]
12.0
10.0
8.0
6.0
4.0
2.0
0.0
M0
M5
M10
M20
M30
M5*
M10*
M20*
M30*
M5**
M10**
M20**

Workability

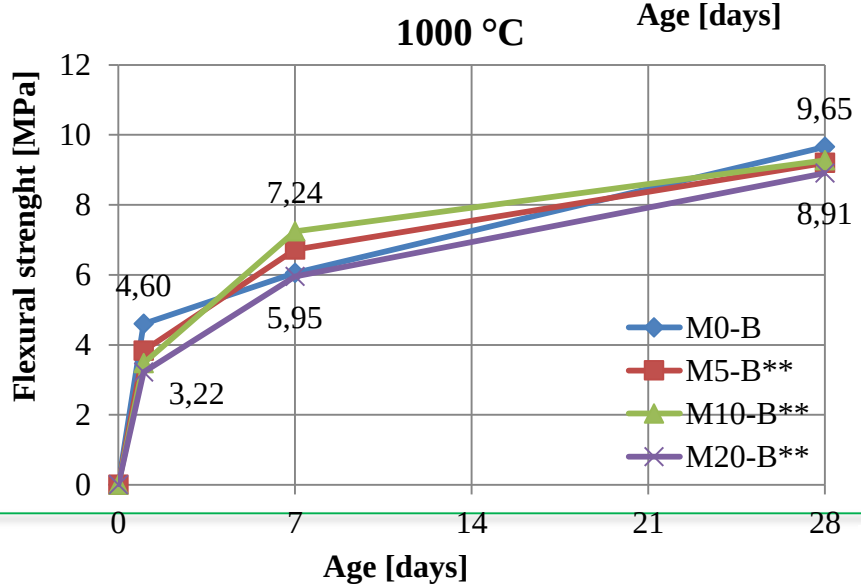


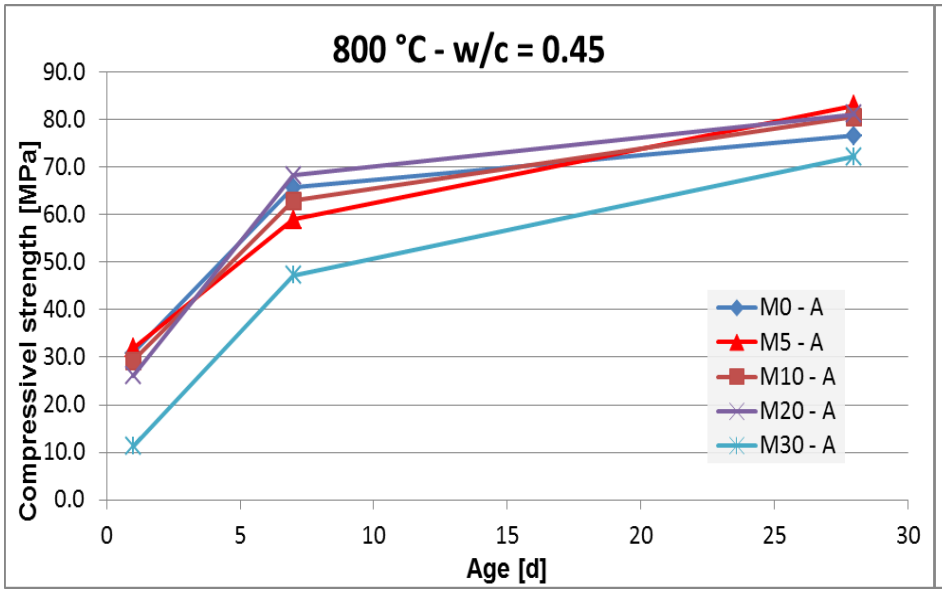


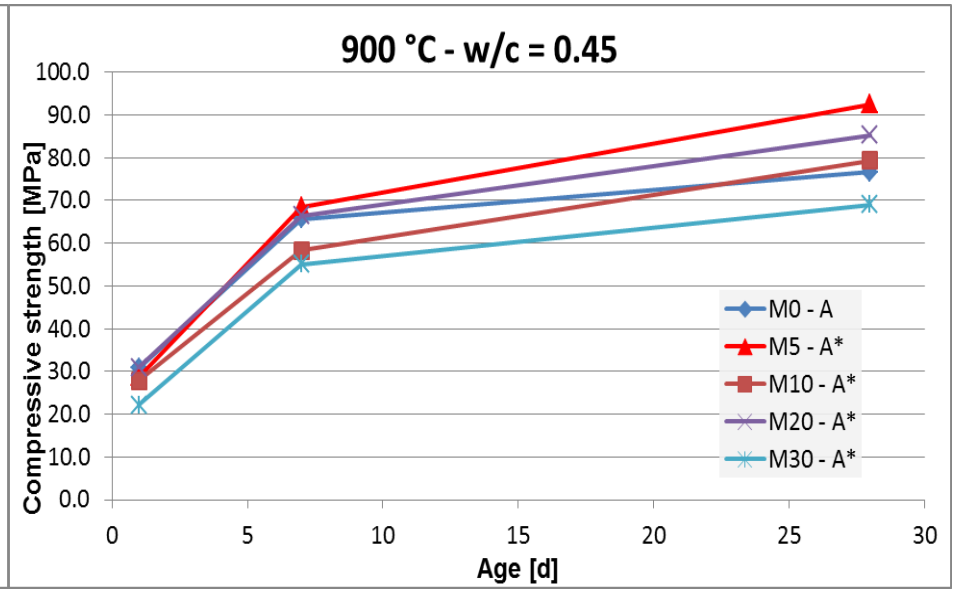


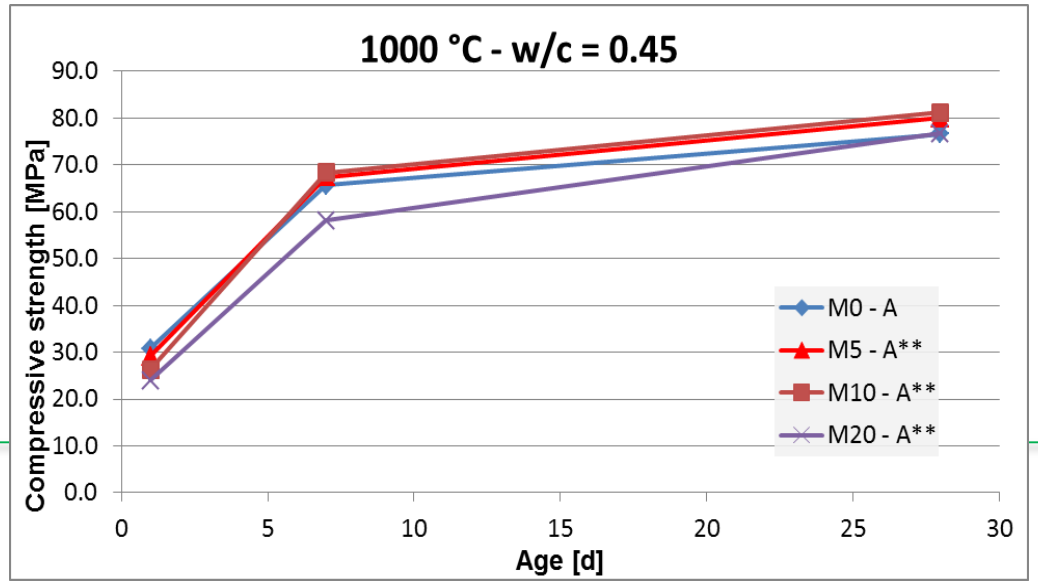


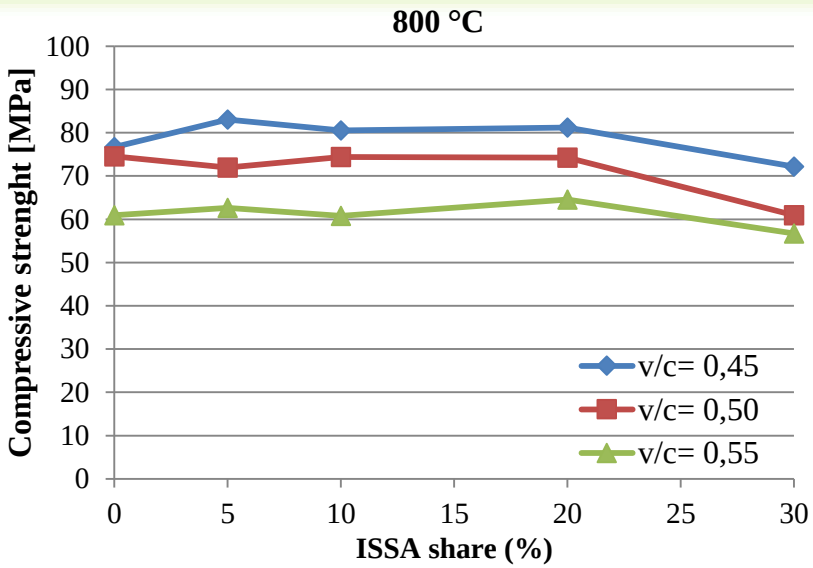
❑ Mechanical properties

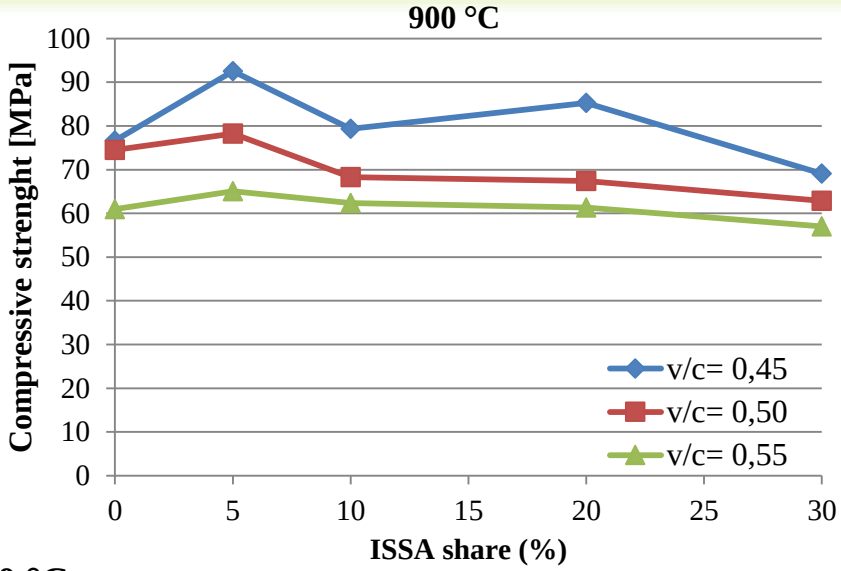



800 °C - w/c = 0.45
Compressive strength [MPa]
Age [d]
M0 - A
M5 - A
M10 - A
M20 - A
M30 - A

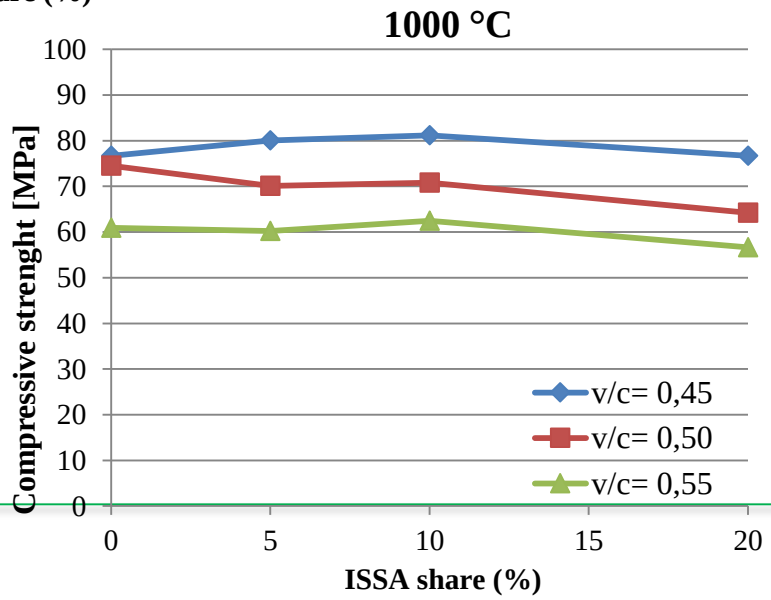

900 °C - w/c = 0.45
Compressive strength [MPa]
Age [d]
M0 - A
M5 - A*
M10 - A*
M20 - A*
M30 - A*


1000 °C - w/c = 0.45
Compressive strength [MPa]
Age [d]
M0 - A
M5 - A**
M10 - A**
M20 - A**





- **Mechanical properties (after 28 days)**



POSSIBLE PROBLEMS IN ISSA RECYCLING:

- ***Sludge incineration*** – content of flying ash in exhaust fumes
- ***Environmental impact*** – leaching of heavy metals
- ***Loss of potentially valuable phosphorus***, as a non-renewable and limited resource on Earth
- ***Legislation*** – lack of comprehensive legislation and guidelines that would define the possibilities and fields of use
- ***Sociological impacts***

CONCLUSIONS:

The reuse sewage sludge:

- helps reduction of energy consumption,
- contributes to conservation of natural (non)renewable resources,
- reduces enormous quantities of waste material disposed into the environment.

Mortar materials ISSA exhibited similar mechanical properties as reference mixtures. So, considering technical specification, the utilization of ISSA in concrete industry therefore appears possible and feasible.

Thank You !

Acknowledgments

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