Direct electric heating of concrete mixture as energy-efficient approach of accelerated curing

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Accelerated curing methods widespread in Russia

- Steam curing   Efficiency 20-30 %

- Accelerated curing in gas combustion products   Efficiency 20-40 %

Direct electric heating methods

- Direct electric curing

- Forced direct electric heating of concrete

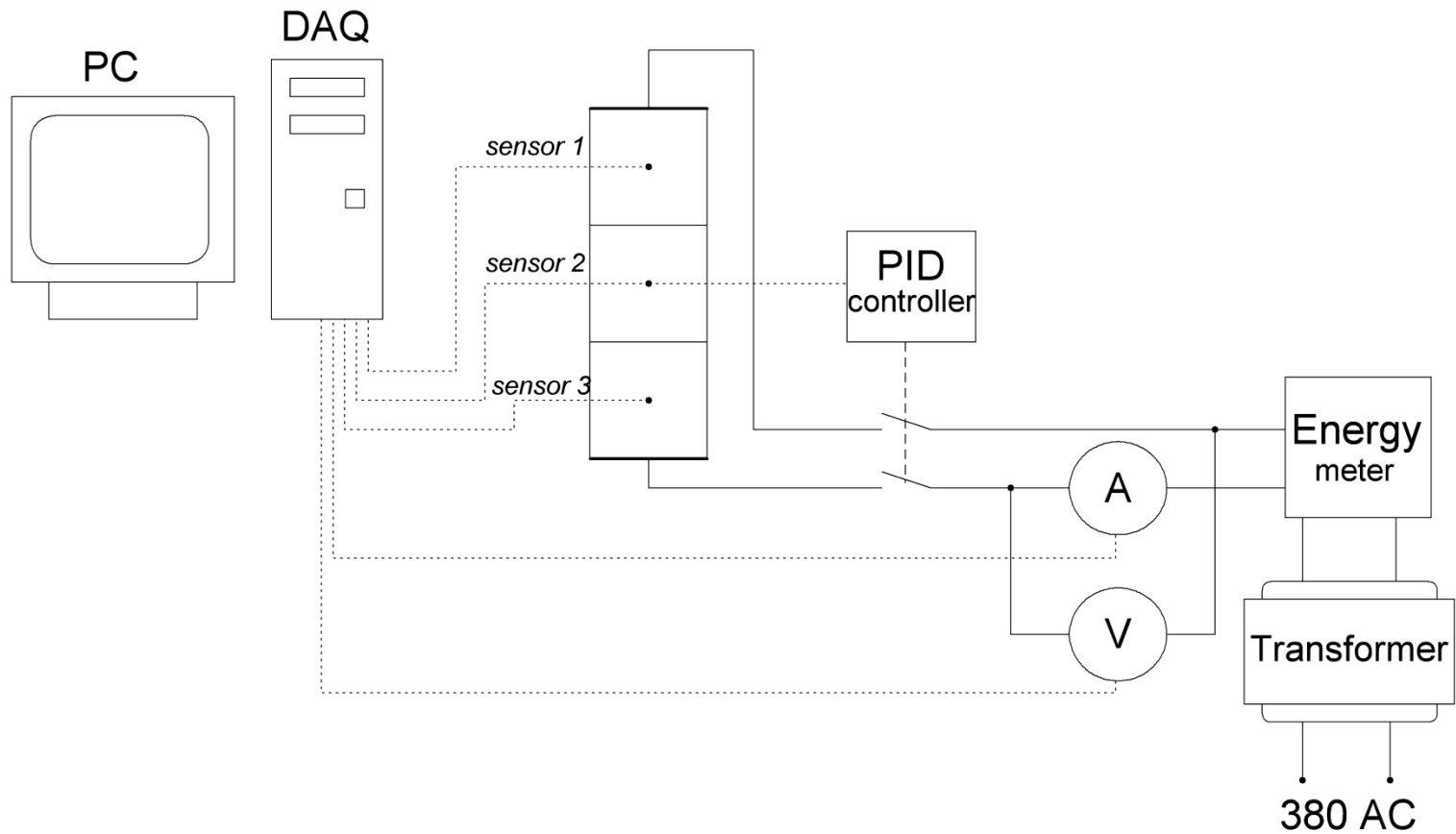- Preliminary direct electric heating (preheating) of concrete mixture
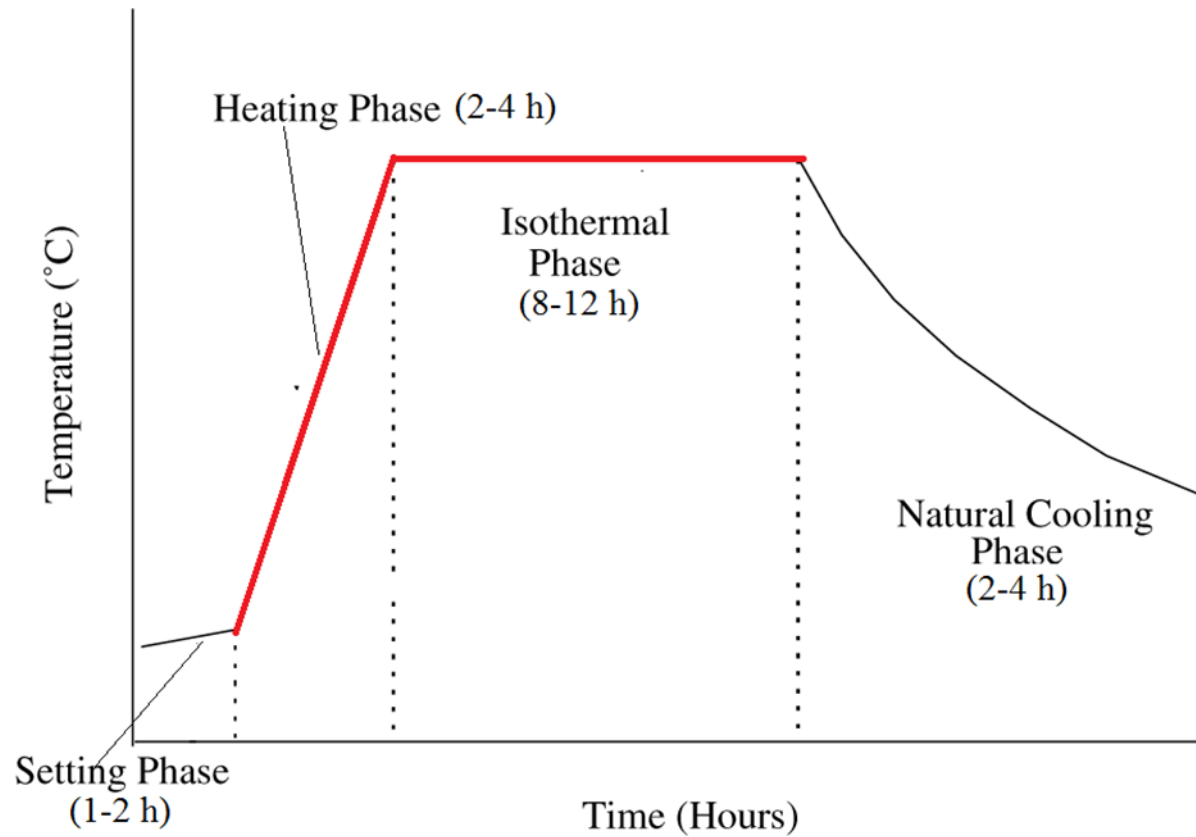
General form of temperature curve used with accelerated curing techniques.
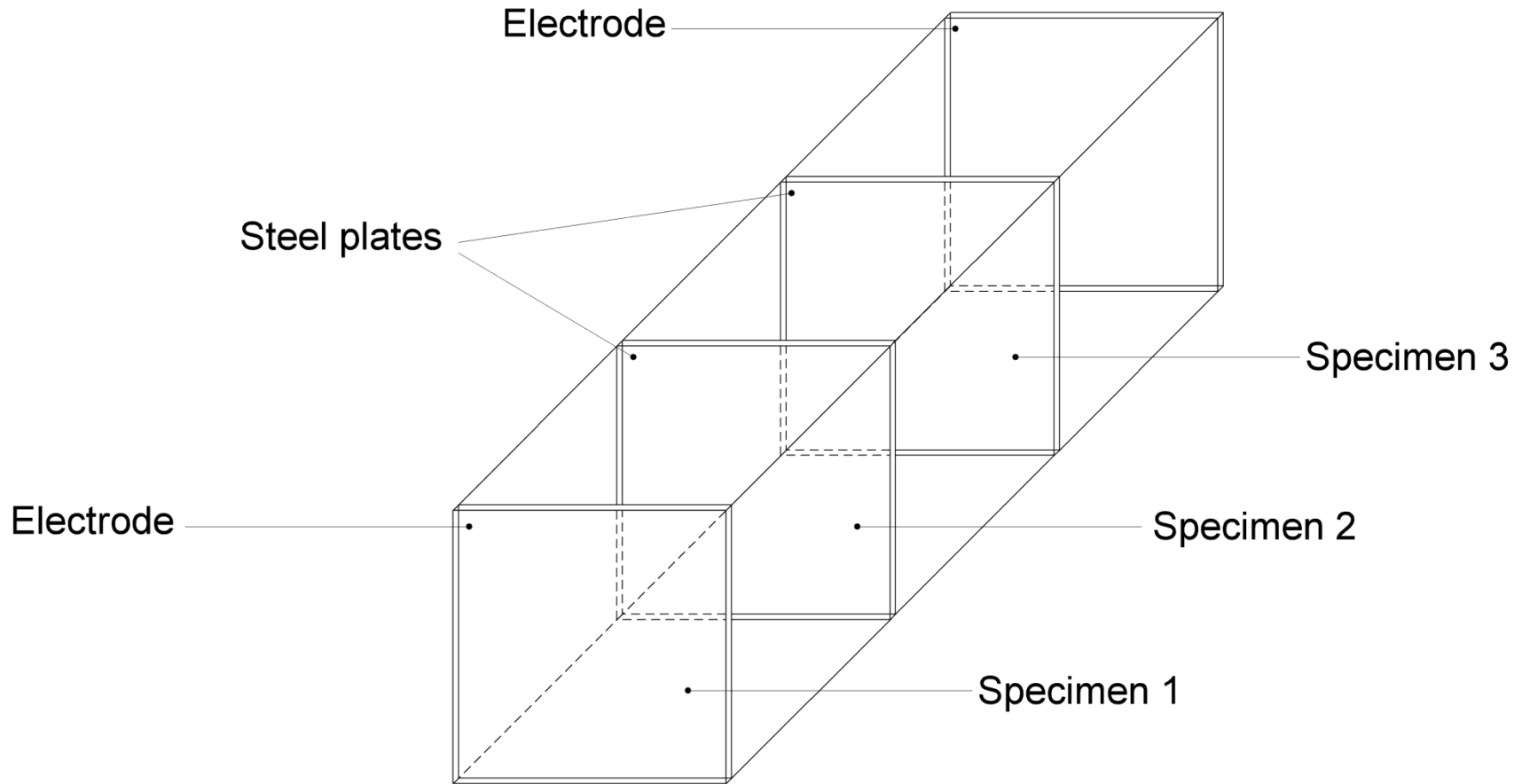
The purpose of experiments

- Heat concrete to a temperature of 50, 60 and 70 ^{0}C in 10 minutes, disconnect from power source and insulate

- Study the dynamics of temperature change and distribution

- Evaluate the effect of temperature conditions on strength and energy consumption
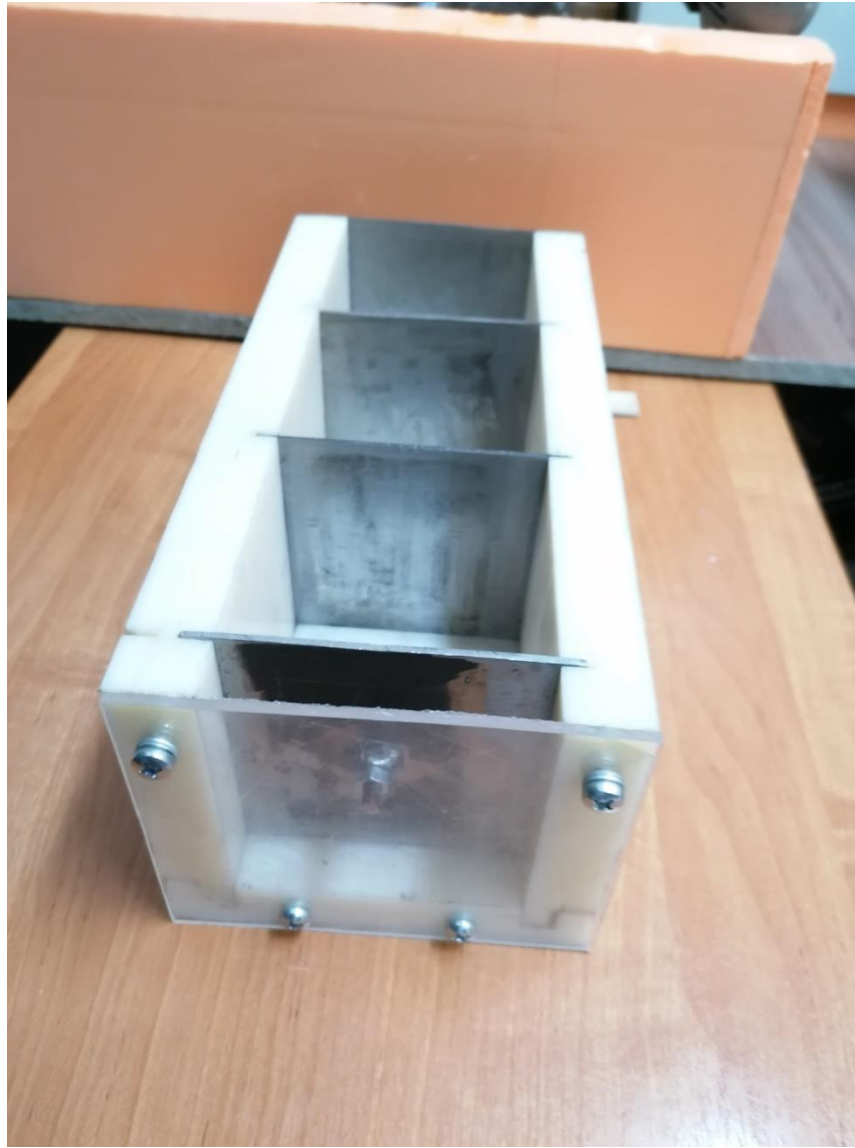
Equipment

- Polyamide mold with steel electrodes and plates for forming three samples with dimensions of 100 x 100 x 100 mm

- Power supply, energy meter, amperemeter, voltmeter, PID-controller, relays

- Temperature sensors, DAQ system, PC.

PC

DAQ

sensor 1

sensor 2

PID
controller

sensor 3

A

V

Energy
meter

Transformer

380 AC

Experiment scheme

Electrode

Steel plates

Specimen 3

Electrode

Specimen 2

Specimen 1

Design of mold

The mold

Cover for insulating the mold

Mixture composition

| Component	Type	Content (kg/m^3)
Cement	ЦЕМІ 42,5 Б	350
Sand	2-2,5 mm	810
Gravel	5-20 mm	1100
Water	-	158

Heating of fresh concrete

Variation and distribution of temperature when concrete is heated to 50 °C
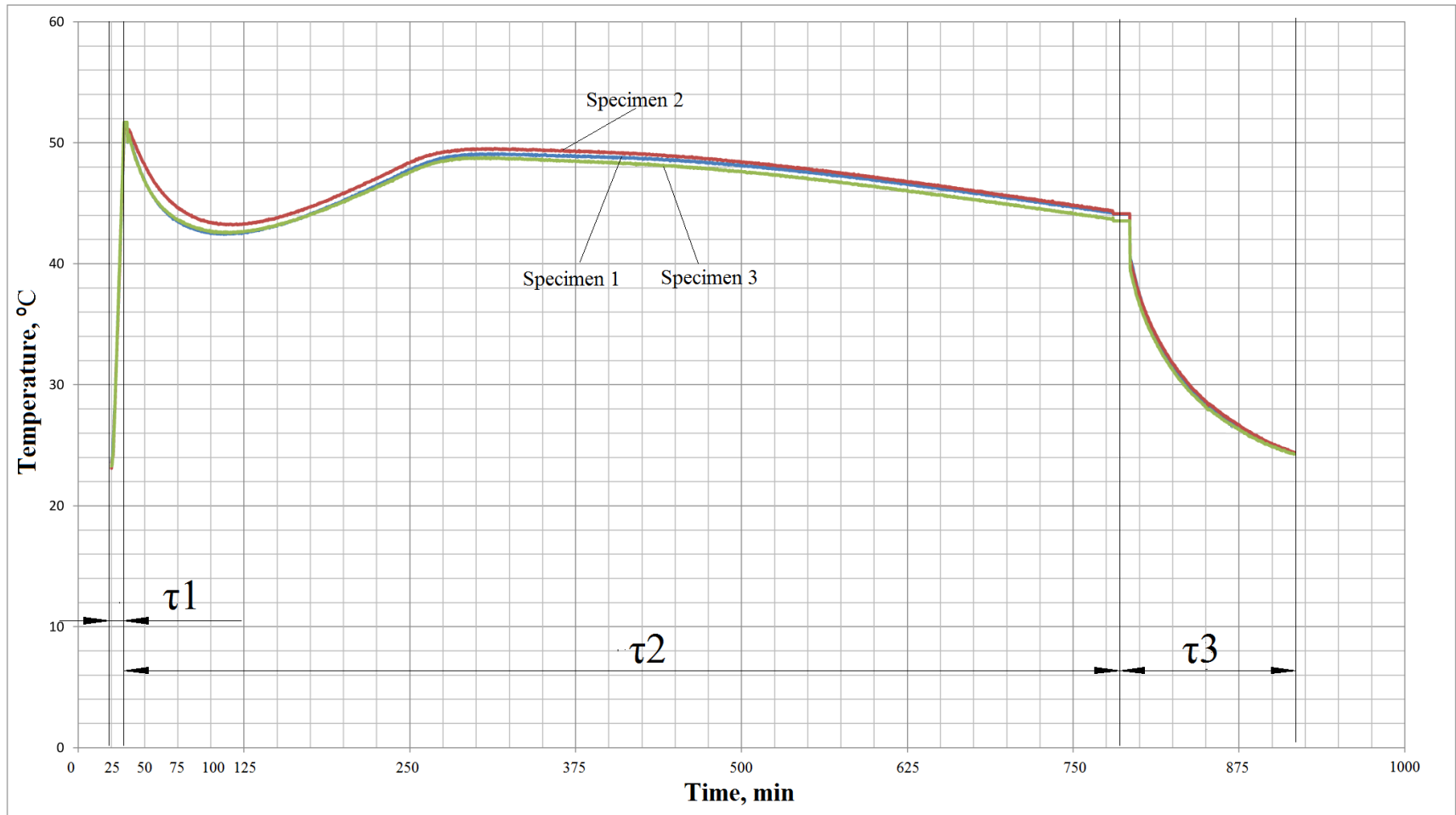
τ1 – Heating phase (10 min.); **τ2** – Isotermal phase without additional heat source (13 h.), **τ3** – natural cooling phase (3 h.)

Average temperature variation of specimens heated to 50, 60 and 70 °C
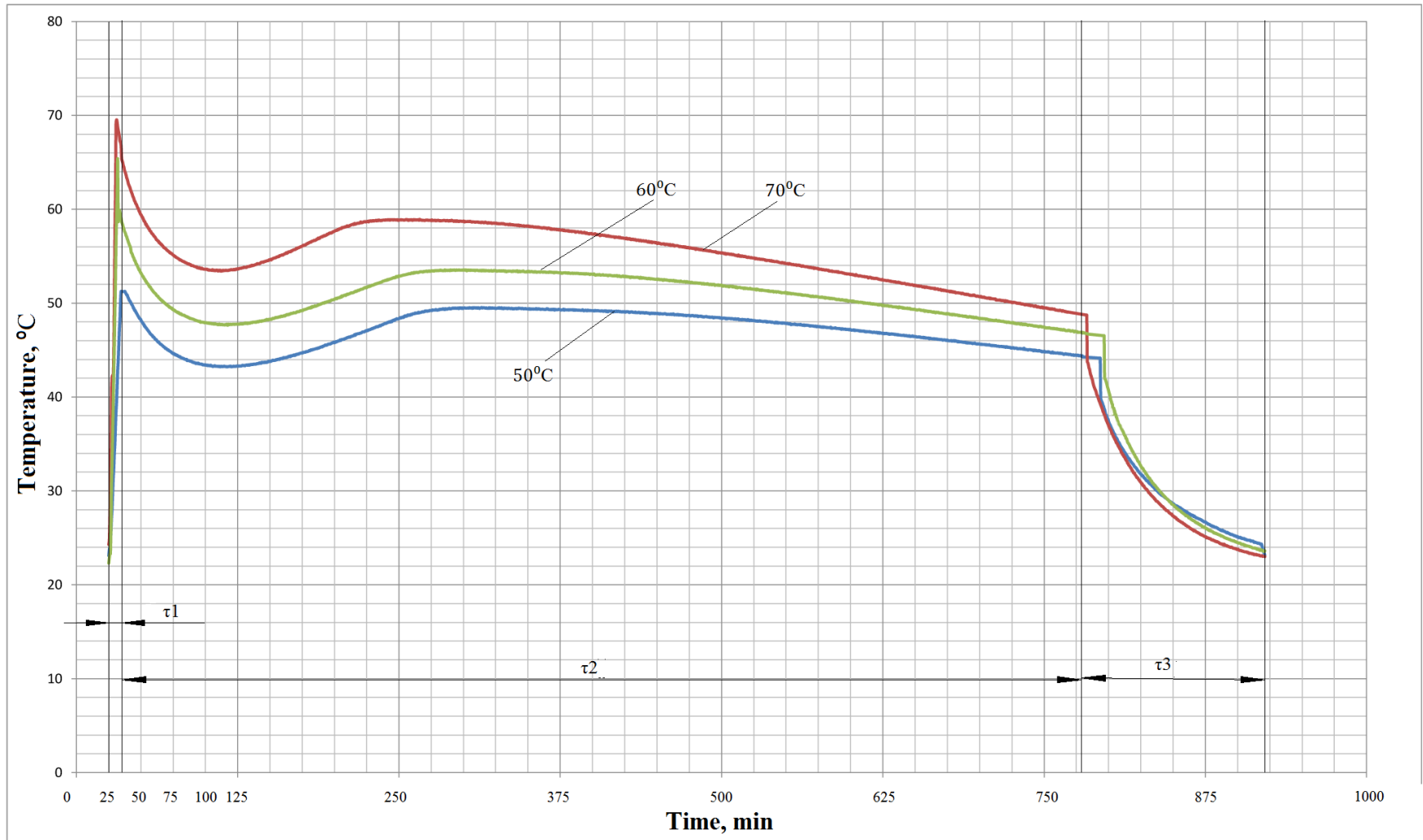
τ1 – Heating phase (10 min.); **τ2** – Isotermal phase without additional heat source (13 h.), **τ3** – natural cooling phase (3 h.)

Samples after insulation removing

Samples after demolding. Natural cooling phase.

Data for experiment

Experiment maximum temperature, °C	50	60	70
Energy supplied (kWh)	0,07	0,1	0,13
Average compressive strength, MPa	28,83	30,06	31,97
Percentage of expected strength, %	88	92	96

Thanks for attention!