# Introduction

IMET

JSC "Moscow Institute of Materials Science and Efficient Technologies" is the successor of OJSC "Moscow IMET", established in 1988 in the USSR under State Construction Committee.

The institute conducts fundamental and applied studies, creating dozens of new, innovative and ecologically clean and efficient materials and products for construction industry and consumers. Institute implemented multiple projects in Russia and abroad (China, United Arab Emirates). The most valuable of them are protected by more than 90 Russian and foreign patents.

Scientific and technical products of the Institute are certified and meet international quality standards.

**General director**

ZAO “Moscow IMET»

**Marsel Yanovich Bickbau**

Well-known scientist in materials science, crystal and physical chemistry of silicates, the author of the first discovery in physics and chemistry of silicates, registered in the State Register of Discoveries of the USSR under № 210. He is the holder of more than 200 patents and scientific papers. Doctor of Chemical Sciences, International Academy of Ecology, Man and Nature, Russian Academy of Natural Sciences, St. Petersburg Engineering Academy, the New York Academy of Sciences, he is the first who synthesized crystals and deciphered atomic structure of calcium silicates and other minerals, cement, developing the basis of mineralogy and physical chemistry of energy-saving technology of “alinit cements”. Under his leadership, the Institute worked out a number of advanced technologies for production of environmentally friendly construction materials based on the principles of Mechano-chemistry of dispersions, micro-and macro-encapsulation and self-organization structures. One of his most significant achievements is the cement binding of a new generation, super-filled plastics, wood products without phenolic binders, shell pigments, etc.

# Capsulation – method for creation of compositional materials of a new generation

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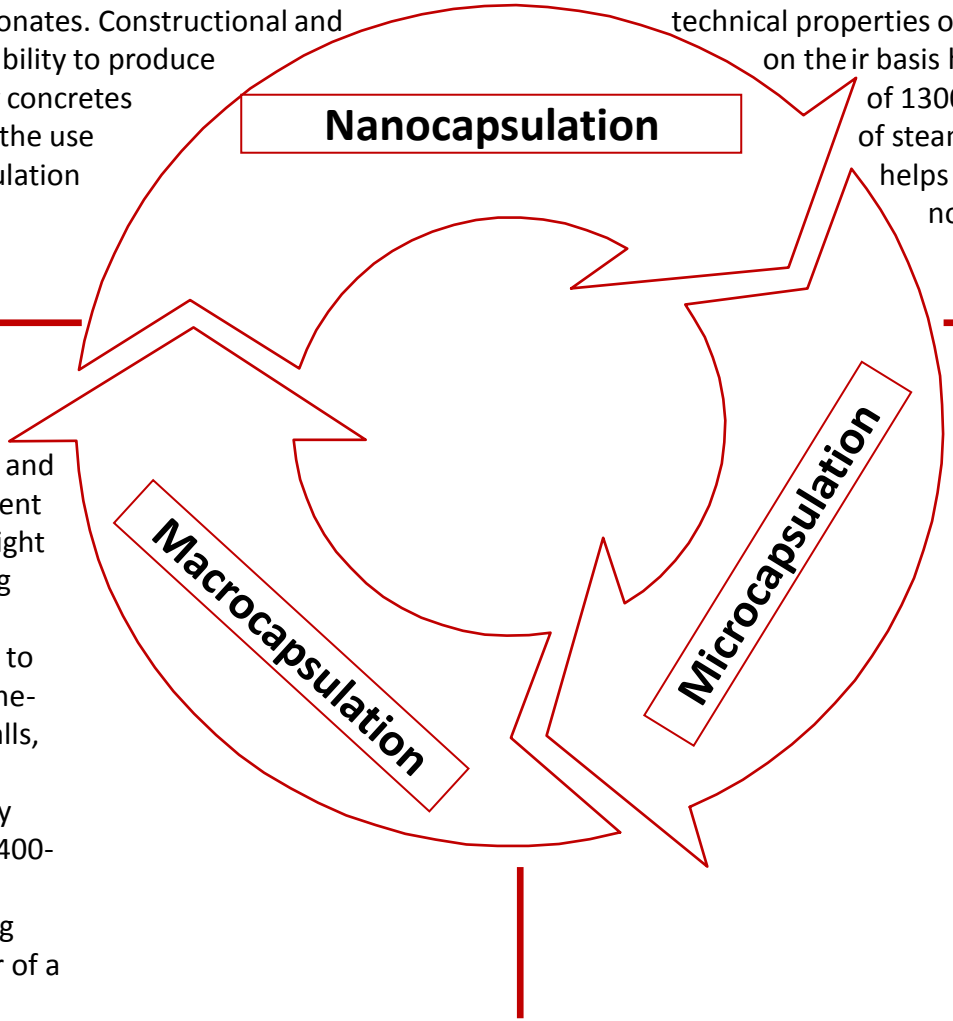
Capsules of nanocement are obtained by mechanical activation of cement dispersion, forming as a composites, consisting of nuclear particles of cement, ranging in size up to 2-3 mkm, coated with thin membranes (thickness in the range of 10-100 nm) of modified naphthalene sulfonates. Constructional and technical properties of mechanically activated cements provide the possibility to produce on their basis high-strength concretes of 500–800 brands and heavy-duty concretes of 1300–1500 brands, a wide range of concrete products without the use of steaming. They are fast hardening, waterproof, etc. Nanocapsulation helps to produce high quality cements with no expiration date.




Capsulation of various light and heavy aggregates with cement milk for the production of light no-fine concrete of cladding structures.
The new technology allows to industrially produce light one-layer and heavy exterior walls, designed from the encapsulated expanded clay gravel with bulk density of 400-600 kg/m3 and cement consumption, not exceeding 100-120 kg per cubic meter of a wall.

Solving the problem of compatibility of different materials such as poly-and polyvinyl chloride, silica sand and sawdust, rubber and magnetic powders. The average size of dispersions for new composite materials is tens of microns.

# Capsulation: new characteristics of new materials

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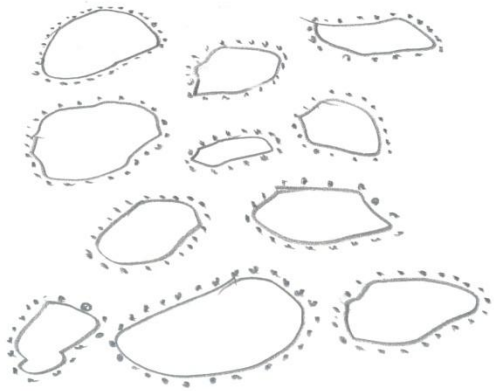
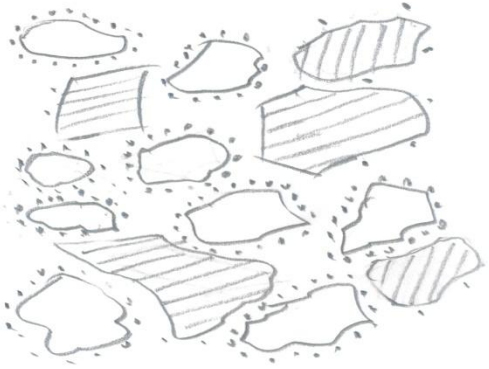
## Nanocapsulation

Under mechano-chemical processing of cements with mineral additives, nanocapsules are formed solely on the surface of cement particles, not spreading further to dispersions of mineral additives. This is explained by radically different state of the surface of cement and silica additives under grinding and triboactivation of the particles, which saturate naphthalene sulfonate by calcium, turning it into new compound C10H7SO3Ca (naphthalene sulfonate of calcium). In this case we observe the intensive growth in the strength of cement stones in concrete even in the face of low quality of cement in concrete mixture.

a)



b)



10мкм

Structure of nanocements – SMS:
a) SMS-100; b) SMS-50.

By dots we outlined the particles and capsules of adsorption complex of nanocapsulated grains of clinker. Particles of mineral aggregate are shown by lining. The scale is indicated above.

# Nanocements are drastically different from usual cements in key parameters

Nanocapsulation

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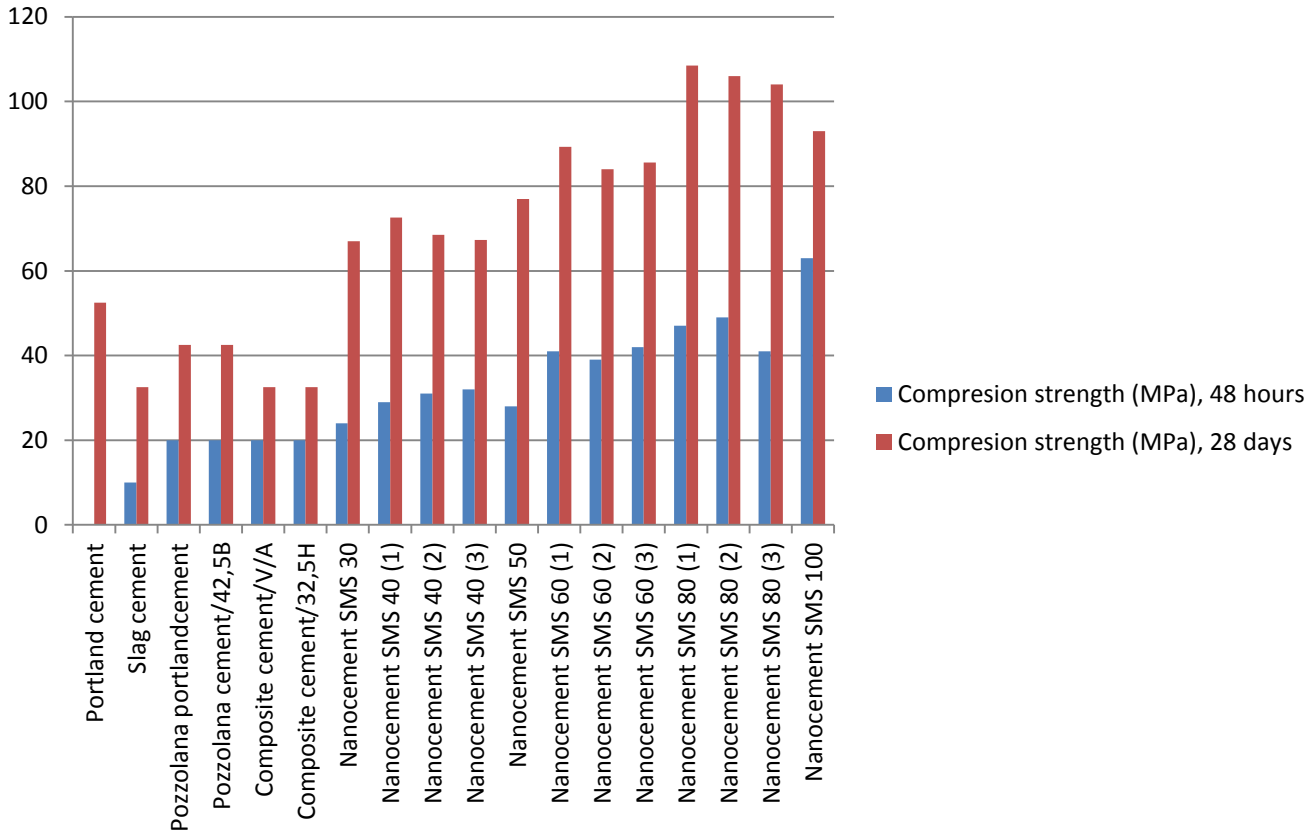

# Nanocements: competitive advantages

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**Mechanically activated cements allow to:**

- Produce concretes of high and super high strength (higher than B60 class) with high water resistance (W12–W20) and resistance to sulfates, chlorides and soft acids
- Economize 30–50% of steel (reinforcement) in strong and super strong concretes
- Speed up hardening of materials, which reach 60–70 MPa of strength within 24 hours , and within 72 hours – acquire strength no lower than 70% of branded strength of concrete, aged 28 days.
- Reduce by 2–4 times consumption of cement under the production of binding substance branded as 300–500 due to joint mechanoactivation of silica additives (fined-grained sand, ash, slags)
- Process portland cement and clinker, autonomously or within existing technological process of cement production
- Reduce consumption of energy and resources in production of concrete by excluding steaming practiced for quicker hardening of products
- Produce architect concrete of enhanced ornamentality (pure tone, bright color) resistant to salt efflorescence on the surface of a product which could be the result of exploitation in contaminated conditions of megapolises
- Produce products from architect concrete with the characteristics close to natural granite but cheaper by 3-5 times with the possibility of grinding and polishing

# Drastic economy under new characteristics

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**Concrete produced on the basis of nanocements allow reduction of consumption of cements used in construction of:**

- High-rise buildings and blocks
  - In supporting columns – by 2–3 times
  - In slabs – by 1,3–1,5 times
  - Speed up the turnover of formworks – from 2 to 3 times
  - Reduce overall costs of carcasses of the buildings – from 20 to 40%
- Hydroengineering facilities
  - Enhance durability – by 2-3 times
  - Reduce consumption of cement – up to 2 times
  - Reduce costs of construction – from 30 to 50%
- Tunnels
  - Reduce cement consumption – by 1,5 times
  - Enhance durability due to waterproof characteristics of concrete – by 2 times
  - Reduce overall costs – by 20–30%
- Bridges and roads
  - Reduce cement consumption – by 1,5 times
  - Enhance durability – up to 2 times
  - Reduce costs – from 15 to 25%
- Defense facilities
  - Increase strength of the buildings – from 2 to 2,5 times
  - Increase sustainability and durability – from 3 to 5 times

Macrocapsulation

# New generation of no-fines concretes

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The consumption of portlandcement used in CAPSIMET is no more than 100-120 kg/m3.

In comparison, usual concretes are produced with portlandcements of no less than 300-400 kg/m3

IMET worked out new technology of no-fines concrete.

We call it CAPSIMET technology. It is capsulation of large aggregates by binding (cement milk) in special equipment – capsulators

Large lightweight or heavy aggregates (fractions from 5 to 40 mm) are covered by shell (capsule) of binder for a few minutes due to intense physical force. The binder interconnects particles of coarse aggregate in a solid structure – light no-fines concrete.

Volume weight of produced no-fines concrete varies from 200 to 1600 kg/m3.

# New generation of no-fines concretes

IMET

**Macrocapsulation**

It is next to impossible to produce no-fines concretes in conventional concrete mixers. The issue is continuous coating of each particle of coarse aggregate in a uniform layer, i.e. shell of the binder with a very small fraction of plaster in the mixture

**We point to the following characteristics of this material:**

- Simple two-component composition of the solid part of the concrete mixture
- Light unit weight
- Bright insulation properties
- High air permeability
-The ability of water filtering
- Low cost of concrete mixture

**These no-fines concretes are utilized in the following spheres:**

- construction of different frame structures;
- manufacture of filtration concretes for road construction, hydraulic concretes used for drainage

**Light (1200-1800 kg/m3)**
**Crushed aggregates +cement**
**Constructional concrete**
**M25-M50**

**Special Light (300-900 kg/m3)**
**Expanded clay + cement**
**Constructional-insulating concrete**
**M10-M25**

**Super light (150-300 kg/m3)**
**Polystyrene +cement**
**Insulating concrete**
**M3-M10**

1)

Macrocapsulation

# New mobile and stationary equipment/ capsulators-mixers

IMET

Stationary and mobile units with rotating cameras make vibrational motions so that, upon adding of cement milk, intense alternating voltages emerge, forming in a chamber vortexes of petty droppings of binder mixture. Moving with shock-vibrational coupling over spiral trajectories, filler particles are dispersed and activate, roll and seal the thin layer of mortar on the surface of the grains.

**Stationary capsulator-mixer IMET (5 m3/h)**

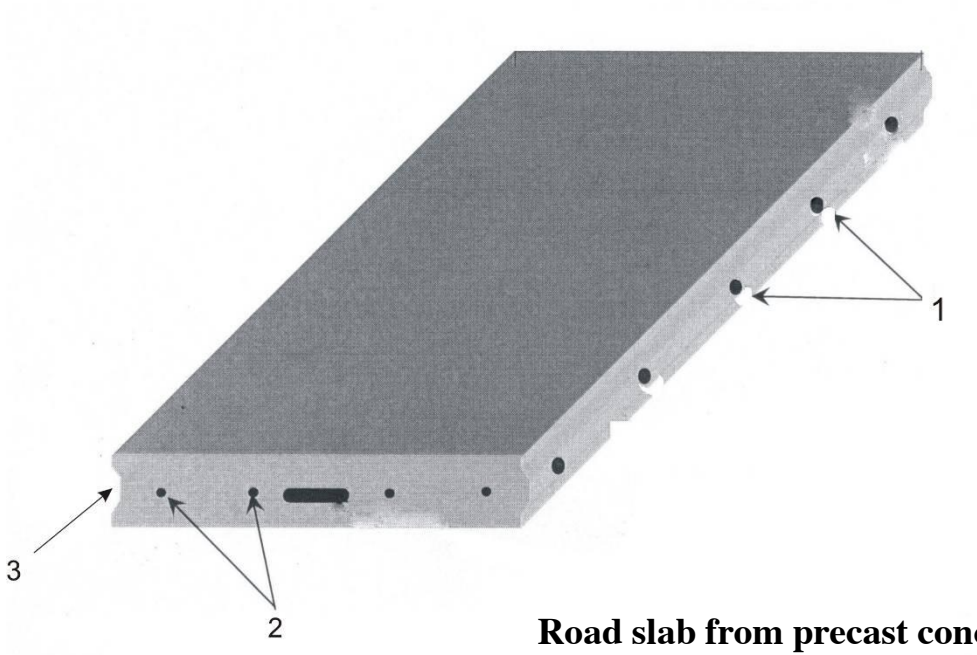
**Mobile capsulator-mixer IMET (2 m3/h)**

# Precast concrete slabs: new technological basis for road construction

IMET

Precast concrete road slabs are manufactured at the works of concrete goods and delivered to the location of road construction

These concrete road slabs are designed with end-to-end channels of 15-25 мм in diameter, directed along the canvas of the slab (and crosswise under construction of broad-lanes roads), and with rebated face shells or flat faces with fixing mortises for arresters




**Road slab from precast concrete:**
**1 – end-to-end channels**
**2- transverse precast reinforcement**
**3-rebated face s of the slab**

# Precast concrete slabs: new technological basis for road construction

IMET

End-to-end channels and rebated faces allow astringing of these slabs along the canvas in packages from 10 to 15 slabs, adjusted by rebated faces or with arresters, attired over steel ropes. They are further laid down over sand layer and plastic wrap, which function as simplified road bed.

Laying of precast concrete slab over the roadbed, designed from drainage sand layer and covered with plastic wrap

# Precast concrete slabs: new technological basis for road construction

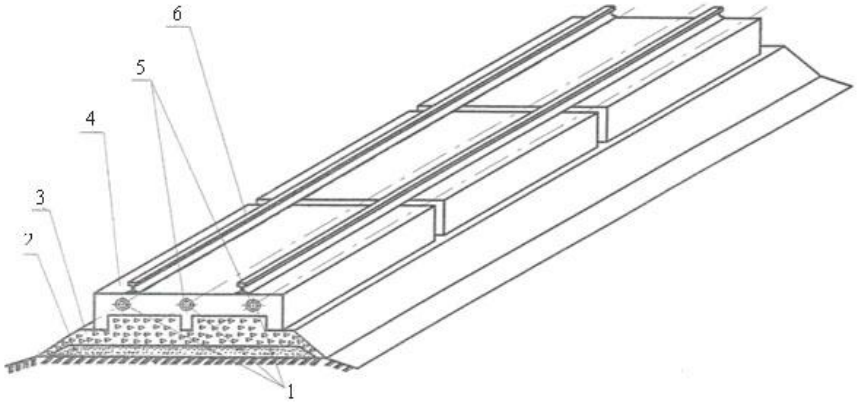
IMET

Labour productivity in laying the roadbed by concrete slabs exceeds the analogous technology for monolithic concreting of roads by 8-10 times.

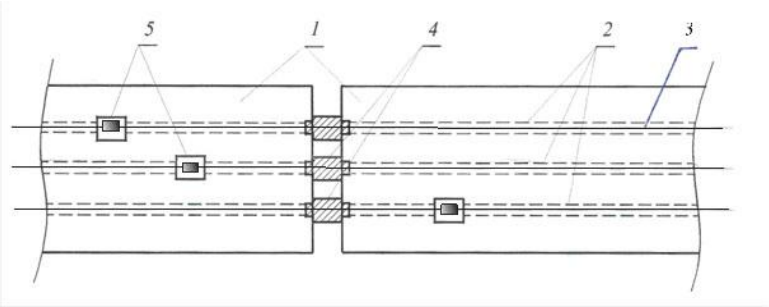
Mobil team of duly equipped workers can construct few miles of high quality highway in a single month.

# Precast concrete slabs: new technological basis for railway construction

IMET



New track structure
1 – steel ropes; 2 – sand bed;
3 – crushed stone bed; 4 – precast concrete slab
5 – end-to-end channels; 6 – steel rails



# Tube confined concrete (TCC): new technological base of modern construction industry

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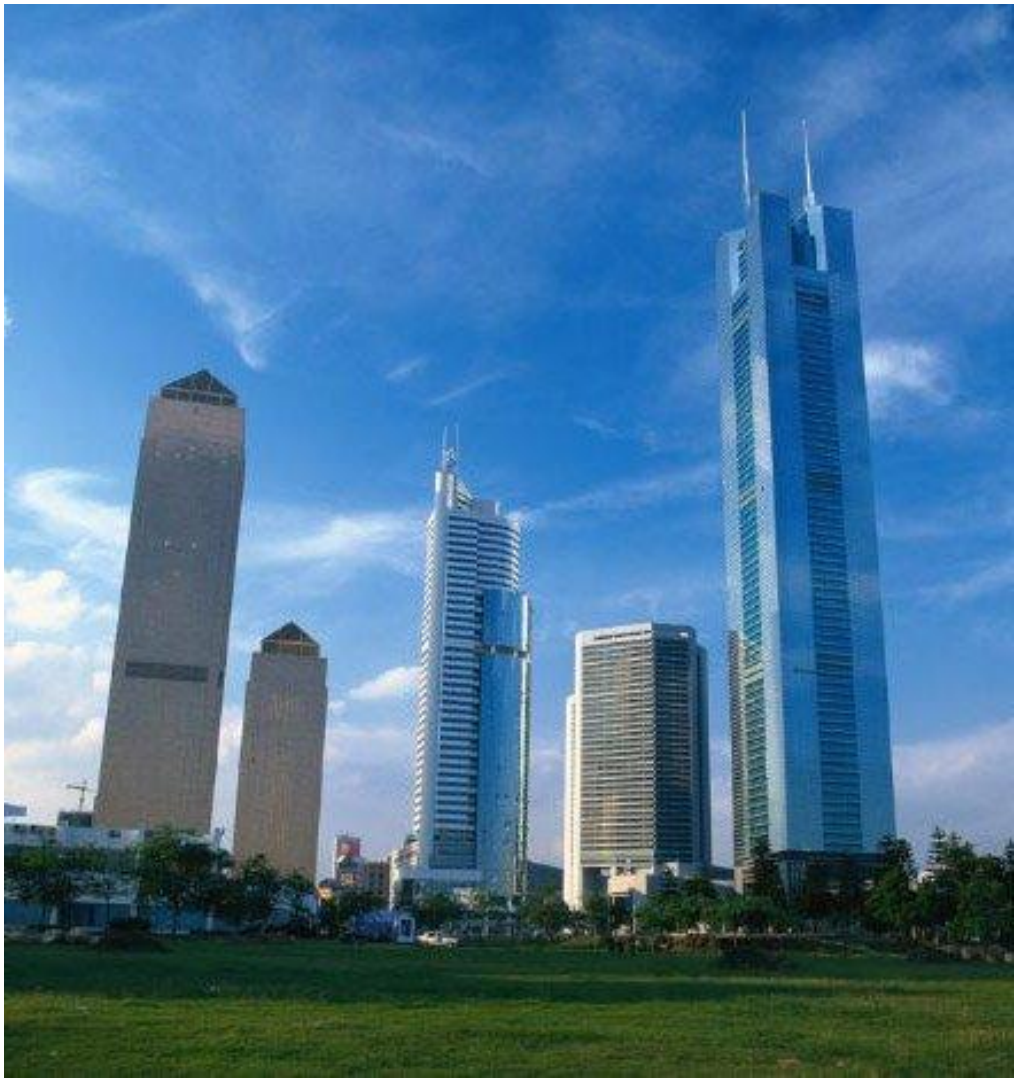

# Tube confined concrete (TCC): sure bet of advantages

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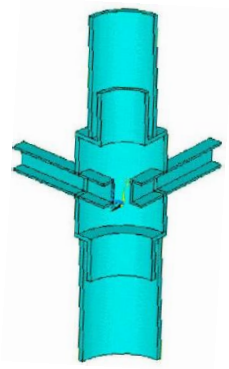
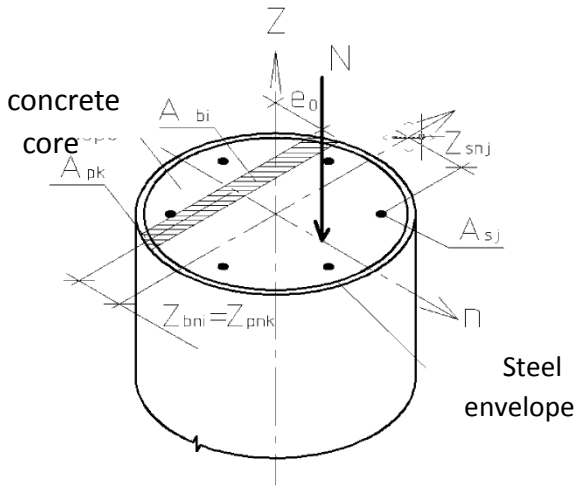
| Design and performance | Technological | Economic |
|---|---|---|
| 1.High carrying capacity of TCC's columns<br>2.Efficiency of steel form performance – pipe instead of steel reinforcement<br>3.Enhancement of strength characteristics, durability and resistance of concrete in the pipe<br>4.Triaxial compression of concrete in the pipe<br>5.Reduction of carrying fabric of the building<br>6.Enhancement of fire resistance in steel construction of a fabric<br>7.High resistance to explosions, seismic instability, extreme stress and impacts. | 1.Steel pipe functions as initial skeleton of a building and permanent form for concrete<br>2.Construction goes for the whole year<br>3.High speed of fabric construction, **3 - 4 times higher** than using classic reinforced concrete<br>4.Reduction by 2-3 times of welding works<br>  | 1.Reduction of steel consumption for the fabric of the building by **1,8 - 2 times**<br>2.Time reduction in construction of carcasses of the buildings by 1,5-2 times<br>3.Reduction in construction costs of carcasses of the buildings by **25 - 30%.**<br>  |

# CAPSIMET in action

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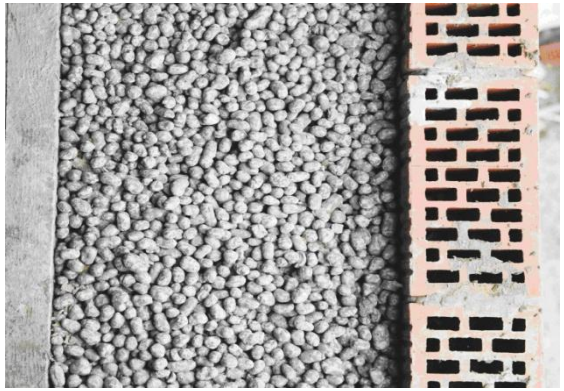

# New two-layers road coat: drainage concrete

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Perforated topping

Lower layer from drainage concrete

Two-layers road coat

# Painting of sands and crushed stones with multiple colors of extended durability: new encapsulation capabilties

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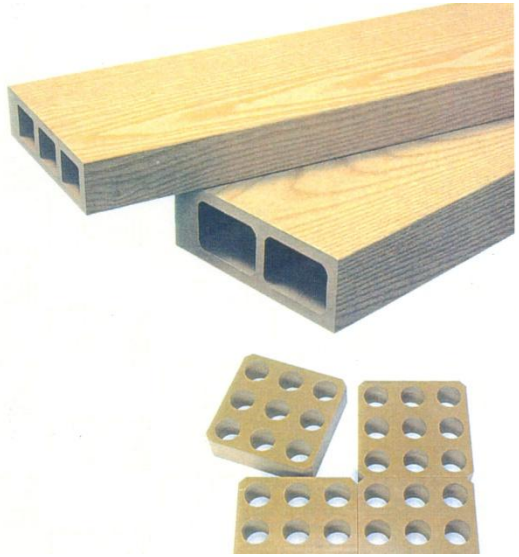
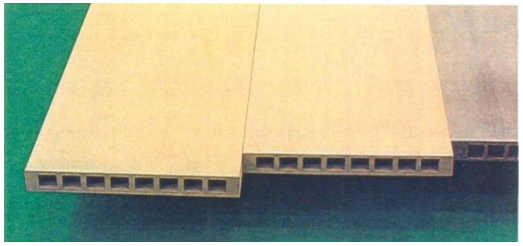
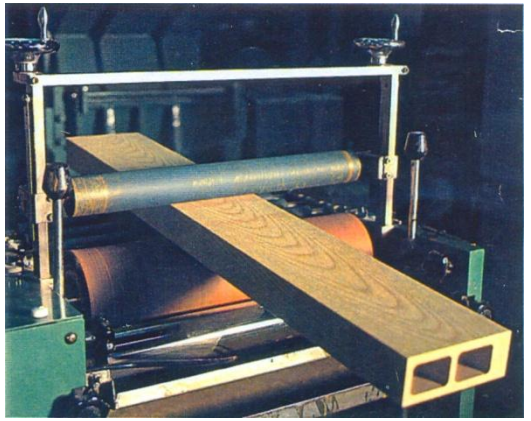
# Samples of products, manufactured by extrusion method from superfilled plastics

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