

CONCRETE TYPES USED FOR ROAD PAVEMENT IN CANADA AND THEIR IMPORTANCE

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**Abstract:** As a country characterized by harsh winter conditions, heavy traffic loads, and frequent freeze-thaw cycles, Canada relies on specialized types of concrete to sustainably build and maintain its road infrastructure. This article provides detailed information on the main types of concrete used in Canadian road pavements, their properties, and how they are adapted to national standards.

**Аннотация:** Как страна, характеризующаяся суровыми зимними условиями, большой нагрузкой на транспорт и частыми циклами замерзания-оттаивания, Канада полагается на специализированные типы бетона для устойчивого строительства и обслуживания своей дорожной инфраструктуры. В этой статье представлена подробная информация об основных типах бетона, используемых в канадских дорожных покрытиях, их свойствах и том, как они адаптированы к национальным стандартам.

Concrete plays a significant role in the construction of road infrastructure in Canada. The country's harsh continental climate, harsh winters, and heavy loads during road operation place high demands on the quality of concrete. This article analyzes the composition of concrete used for road pavements in Canada, their adaptation to climatic conditions, and modern innovative approaches.

Types of concrete used for road surfaces in Canada

The following types of concrete are widely used in road construction in Canada:

- Traditional heavy concrete - used in road base coatings and has high strength.
- Reinforced concrete (reinforced) - concrete reinforced with metal reinforcement to increase the load-bearing capacity of roads.
- Heat-resistant and frost-resistant concrete - concrete enriched with special additives that are resistant to freeze-thaw cycles.
- Water-resistant and hydrophobic concrete - concrete resistant to rain and snowmelt.

Main materials added to concrete in Canada

The composition of concrete consists of the following main components:

- Main components:
  - Portland cement - the main binding material used in Canada.
  - Stone and sand - obtained from a local raw material base, the strength of which affects the final quality of concrete.
  - Water – clean, mineral-free water is required for chemical reactions in concrete.
- Additional components:
  - Mineral additives – silica fume, fly ash, and granulated slag increase the strength and long-term durability of concrete.
  - Chemical additives – superplasticizers, air-entraining modifiers, and antifreeze additives improve the performance properties of concrete.

Canadian Climatic Conditions and Their Impact on Concrete Composition

Canada's climate plays an important role in shaping the composition of concrete:

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- Cold weather and freeze-thaw cycles - air entraining admixtures are added to concrete to create air bubbles and make it frost-resistant.
- Thermal expansion and contraction in pavements - thermal temperature differences increase the need to use plasticizers in concrete.
- Changes in humidity and atmosphere - the use of hydrophobic admixtures increases the water resistance of concrete.

Quality standards for concrete used in Canadian road construction

Road concrete in Canada must comply with the following standards:

- Canadian Standards Association (CSA) requirements - road concrete must meet strict requirements for quality and strength.
- Comparison with ASTM and AASHTO standards - compliance with concrete standards based on international experience is ensured.
- Laboratory tests and strength criteria – each type of concrete undergoes special tests to determine its strength, elasticity and durability.

Innovative solutions in the composition of Canadian road concrete

The following innovative technologies are used to improve the composition of road concrete in Canada:

- Eco-friendly concrete types – concrete made from recycled materials does not harm the environment.
- Nanotechnologies and high-strength concretes – strength and durability are increased using nanomaterials.
- Self-healing and climate-adapted concretes – concretes that self-heal cracks through microbiological and chemical composition are being developed.

Types of Concrete Used for Road Pavements in Canada

The types of concrete used in road pavements in Canada are selected taking into account harsh climatic conditions, heavy traffic loads and resistance to freeze-thaw cycles. The main types of concrete and their properties that comply with Canadian standards, in particular CSA A23.1, are listed below.

#### 1. Air-entrained concrete

Properties:

- Contains microscopic air bubbles, typically 3–6% of the volume.
- Increases resistance to freeze-thaw cycles and reduces the likelihood of concrete cracking.
- Provides high resistance to moisture and frost.
- Resistant to road salts and chemical attack, extending the service life of concrete.
- Reduces surface tension, reducing the possibility of concrete settling and damage.

Applications:

- Primary road surfaces
- Bridges
- Walkways
- Concrete structures in cold climates

#### 2. High-Strength Concrete (HSC)

Characteristics:

- 28-day strength: 40–70 MPa (according to Canadian standards, CSA A23.1).
- Made with high-quality cement, superplasticizers and low water-cement ratio.

- Resistant to abrasion and cracking.

Applications:

- Heavy-duty roads
- Highways
- Transportation hubs

### 3. Fiber-Reinforced Concrete (FRC)

Properties:

- Polypropylene, steel or glass fibers are added to the composition.
- Increases the bending and tensile strength of concrete.
- Improves resistance to cracking.

Applications:

- Top layer of road pavements
- Airports
- Bridges

### 4. Roller-Compacted Concrete (RCC)

Properties:

- Has a drier mixture and is compacted using special equipment.
- Is characterized by fast drying and low cost.
- Can be stronger than traditional asphalt pavements.

Applications:

- Industrial roads
- Shipping terminals
- Logistics centers

### 5. Pervious Concrete

Properties:

- Has 15–25% voids, allowing rainwater to drain quickly.
- Helps control water flow in urban areas.
- Reduces soil erosion.

Applications:

- Urban sidewalks
- Parking lots
- Water drainage systems

### 6. Rapid-Setting Concrete

Properties:

- Ready to use in 2–4 hours.
- Sets quickly with Calcium Aluminate Cement and other special additives.
- Used in extreme conditions and for quick repair work.

Applications:

- Emergency road repairs
- Rapid bridge repairs
- Airports

Canadian Concrete Standards and Additional Recommendations

The following standards and recommendations are considered when selecting concrete for road infrastructure in Canada:

Basic Standards:

- CSA A23.1: Concrete Composition, Strength and Test Methods.
- CSA A23.2: Methods for Determining Physical and Chemical Properties of Concrete.
- Durability Design: Methods for providing resistance to freeze-thaw and road salt.

Additional Materials:

- Fly ash: Adds strength and durability to concrete.
- Silica fume: Reduces water and increases density.
- GGBFS (granulated blast furnace slag): Improves the strength properties of concrete.

Layered Construction:

- Base course: RCC (reinforced concrete) may be used.
- Top layer: HSC (high-strength concrete) or fiber-reinforced concrete is used.

The types of concrete used in road pavements in Canada must withstand extreme weather conditions, freeze-thaw cycles, and heavy loads. To achieve this goal, high-quality materials, suitable additives, and layered construction methods are widely used. The durability and efficiency of concrete used for Canadian roads ensure long-term service life and are economically viable.

The analysis shows that the composition of concrete for road construction in Canada is optimized for specific climatic and operational conditions. Canadian experience can also be applied in road construction in Uzbekistan, and it is necessary to introduce innovative approaches to the production of frost-resistant concrete, environmentally friendly technologies and increasing strength. Future research should focus on in-depth study of new composite materials and nanotechnologies and their implementation in practice.

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