PROTECTING THE ROAD NETWORK IS A PRIORITY

Every spring, the ministère des Transports, de la Mobilité durable et de l'Électrification des transports establishes the dates for the thaw period for the three zones that comprise the territory of Québec. During this period, heavy vehicles that travel on the road network must reduce their loads in accordance with the limits imposed by the *Vehicle Load and Size Limits Regulation* that applies to road vehicles and combinations of road vehicles.

The coming into effect of load limits because of the thaw invariably raises a number of questions concerning the load limits applied to heavy vehicles, pavements and structures, along with the effects of climate on roads, the procedure used to establish the thaw period, traffic control, etc. In order to answer some of these questions, we have created a series of fact sheets that contain the essential information related to these topics, as well as maps and answers to recurring questions concerning pavements and vehicle loads.

It is only logical to subject heavy transport operators to more restrictive regulations during the thaw period, especially considering that the gouvernement du Québec is investing large amounts annually in the repair and upgrade of its road network.

For information concerning authorized load limits during the thaw period, or concerning any other topic, choose one of the options listed below.

- Visit the website of the ministère des Transports, de la Mobilité durable et de l'Électrification des transports: **www.transports.gouv.qc.ca**
- Call **511** (in Québec)
  1-888-355-0511 (from anywhere in North America)
- Send an email to:
  communications@transports.gouv.qc.ca
- Write to the following address:
  Direction des communications
  Ministère des Transports, de la Mobilité durable et de l'Électrification des transports
  700, boul. René-Lévesque Est, 27e étage
  Québec (Québec) G1R 5H1

If you require information concerning road transport control, contact the information centres of the Société de l'assurance automobile du Québec.

Monday to Friday, 8:00 a.m. to 5:00 p.m.

Québec area: **418-643-7620**
Montréal area: **514-873-7620**
Elsewhere: **1-800-361-7620** (Québec, Canada, United States)

These numbers also give you access to the automated information system, which includes a variety of services and allows you to carry out certain transactions outside of office hours.

Happy reading!

List of enclosures:

- Protecting the road network is a priority
- Fact sheet 1 – Québec roads: background information
- Fact sheet 2 – Bridges: an essential component of the road network
- Fact sheet 3 – Pavement design
- Fact sheet 4 – The effect of climate on pavement
- Fact sheet 5 – Regulations governing loads
- Fact sheet 6 – An overview of the thaw period in Québec
- Fact sheet 7 – Load restrictions during the thaw period
- Fact sheet 8 – Road checks
- Frequently asked questions: pavements
- Frequently asked questions: vehicle loads
- Thaw zones in Québec (map)
- Location of road weather stations and frost probes (map)
- Thaw history: 1977- 2016
- Visual of the "En période de dégel – Roulez léger" (During the thaw period – Travel light) road sign

1 ROADS IN QUÉBEC: BACKGROUND INFORMATION

In post-industrial economies, social interaction and economic activity are closely related to the functionality of the road network. Québec is no exception to this rule.

The mission of the ministère des Transports, de la Mobilité durable et de l'Électrification des transports is to ensure the mobility of people and goods throughout Québec on safe, efficient transportation systems that contribute to the sustainable social and economic development of Québec. The road network is one of these systems.

Various factors, including demography, the increase in the number of driver's licences and the vehicle fleet, especially in the past 25 years, as well as climatic conditions specific to Québec, have made it crucial to understand the phenomena that modify the behaviour of road structures, in order to ensure their efficient and proactive management.

The ministère is responsible for maintaining approximately 30 600 km of road infrastructures, including freeways, national highways, regional highways, and collector roads. This road network, which is valued at several billion dollars, interconnects all of the regions of Québec, providing access to markets and resources. This network is vitally important in terms of supporting the Québec economy.

In fact, road travel is the preferred mode of travel for a significant percentage of the population, and for many shippers who transport goods to Québec, to other parts of Canada, and to the US market. The increase in the car population and in the number of driver's licences testify to the need of Québecers for mobility. Trips are higher in number and are distributed differently across the territory, over time and depending of the seasons.

Increase in demand

In Québec, between 1987 and 2012:

- the population increased by 19 %;
- the number of driver's licences increased by 38 %;
- the number of vehicles increased by 67 %;
- the number of heavy trucks and road tractors increased by 54 %.

During this same period, the length of the road network has changed very little. Some noteworthy improvements have been made to the existing network, particularly to the design of slow lanes, the redesign of intersections, and the widening of certain lanes.

Methods involving design, materials, construction techniques, quality control, and infrastructure management are all areas where knowledge has increased significantly. Understanding the phenomena that alter the behaviour of structures is essential in order to be able to face the demand that we are experiencing today.

1 ROADS IN QUÉBEC: BACKGROUND INFORMATION

A harsh climate

In addition to the traffic volumes involving light vehicles and the loading methods for heavy cargo, a number of factors influence road design, the choice of materials and pavement management. Some of these criteria are dictated by characteristics that are unique to Québec, where the road network is subject to particularly harsh climatic conditions, with temperatures that are very cold in the winter and very hot in the summer. This creates variations of approximately 60 °C during the year. In winter, when the ground freezes to depths varying from 1.2 to 3.0 metres for a period of more than four months, the temperature can change by as much as 25 °C in only a few hours. This situation is obviously not good for the roads. In fact, a quick drop in temperature in the winter or spring can cause premature deterioration of the pavement and the driving surfaces.

After resisting the effects of deformation caused by deep frost, the roadway must continue to support significant loads during the thaw period, when it is weakened by between 30 % and 70 % as a result of water absorption. The immensity of the Québec territory, the low density of the population, the extremely harsh climate, and the intensity of traffic make Québec one of the places in the world where ensuring the quality of public travel through the effective conservation and management of a reliable road network remains a constant challenge!

Specific soil mechanics

The majority of the inhabited land in Québec is made up of clay materials that were deposited in ancient lakes and glacier seas during the last episode of Wisconsin glaciation. The design and construction of road infrastructures on this sensitive clay requires that geotechnical studies be conducted in order to verify the stability and bearing capacity of the soil, which is sometimes inadequate to support the presence of fill that is no more than two metres thick. Since these clayey materials are especially sensitive to frost and thaw effects, the pavement design must be adapted to this special context.

Geotechnical studies are also necessary in order to devise technical solutions to structural problems that affect the behaviour of pavements. Phenomena such as packing, lack of capacity, and support, especially in bogs, require road structure designs to be well adapted. The presence of numerous bogs in several regions of Québec is at the root of the expertise that the Ministère has developed with respect to construction on organic soil.

In fact, several research projects that were subsidized by the Ministère and carried out by Québec universities have made it possible to achieve significant progress in terms of improving the bearing capacity of clay. Experts from the Ministère's Laboratoire des chaussées (pavement laboratory) are also participating in the design and implementation of new techniques for consolidating clay soils. This work is even more important in light of the damage caused to the properties of the materials used for pavements and the supporting soil during the spring.

2 BRIDGES: AN ESSENTIAL COMPONENT OF THE ROAD NETWORK

The structures inventory of the ministère des Transports, de la Mobilité durable et de l'Électrification des transports includes over 4 700 bridges located on the network under its management. Since January 2008, the Ministère has also assumed management of more than 4 200 bridges of the municipal network.

Bridges may be an obstacle to the movement of certain vehicles, both due to their bearing capacity and the clearance offered. However, these constraints imposed by bridges do not depend on climatic conditions. The more restrictive regulations in force during the thaw period are established only for the protection of the pavements.

The Ministère, through the "Trucking" section of Québec 511 on its website, makes two tools available to truckers in order to inform them, at all times, of the limits required by the bridges.

The *Répertoire des limitations de poids* (Register of bridges with weight restrictions) contains information concerning structures that may constitute an obstacle to the free flow of vehicles, due to their limited bearing capacity. Regular inspections to detect defects, evaluations of bearing capacity and work performed on the bridges ensure that the situation in the field is constantly evolving: signs are replaced, added or removed in any period of the year. The Répertoire must therefore be consulted systematically before each trip.

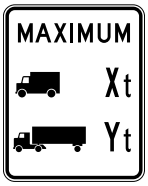
The *Répertoire des hauteurs libres sous les ponts* (Register of vertical bridge clearances) contains data concerning the clearances measured under all road, railway or pedestrian bridges crossing roads under the Ministère's management or numbered municipal roads. The data is also provided for bridges under the Ministère's responsibility that cross unnumbered municipal roads. The data in the Répertoire may be changed after repair or replacement of bridges or addition of new bridges on the network. The work performed on the roadways spanned by the bridges may also change the clearance data. Consulting the Répertoire must therefore be an integral part of the process to determine any transportation route.

For further information, please:
- visit the ministère des Transports, de la Mobilité durable et de l'Électrification des transports website at **www.transports.gouv.qc.ca.**
- call 511 (in Québec) or 1-888-355-0511 (in North America).
- send an email to communications@transports.gouv.qc.ca.

Québec

2 BRIDGES: AN ESSENTIAL COMPONENT OF THE ROAD NETWORK

The following signs are located along bridges and overpasses that have weight limitations.



The Weight Restriction signs inform drivers of trucks* with a total loaded weight exceeding the maximum weight indicated on the signs that they are prohibited from travelling on a bridge. These signs also concern buses. The "X" indicates the total maximum load of a road vehicle, the "Y" indicates the total maximum load of a combination of road vehicles consisting of two units, and the "Z" indicates the total maximum load of a combination of road vehicles consisting of more than two units.

The Weight Restriction sign informs drivers of all road vehicles with a total loaded weight exceeding the maximum weight that is indicated on the sign that they are prohibited from travelling on a bridge. The "X" indicates the total maximum load of a road vehicle or a combination of road vehicles.

The Legal Load Limitation sign informs drivers of vehicles with a mass exceeding the load limits stipulated in the *Vehicle Load and Size Limits Regulation* that it is forbidden for them to travel on certain bridges.

The Trucks Prohibited sign indicates that access to a road is totally prohibited for trucks.

* The truck outline on the signs refers to trucks, tow trucks and tool vehicles.

For further information, please:
- visit the ministère des Transports, de la Mobilité durable et de l'Électrification des transports website at **www.transports.gouv.qc.ca.**
- call 511 (in Québec) or 1-888-355-0511 (in North America).
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Québec

3 PAVEMENT DESIGN

The structure of pavement is simple in appearance only, with hardly a few layers visible above the ground. In reality, the design of pavement is dependent upon many variables, which makes it one of the most complex civil engineering structures.

There are two main categories of pavements, which are divided according to their mechanical behaviour and the type of material used. Rigid pavement is characterized by a concrete driving surface. It reacts as a solid block, and experiences very little distortion under load. Flexible pavement, which is used more frequently in Québec, is covered with a coating commonly known as asphalt. This type of roadway experiences only slight distortion under the flow of traffic and, for all practical purposes, fully resumes its original shape afterwards.

Rigid pavement is generally well adapted to intense traffic, which is characterized by a high volume of heavy vehicles. Flexible pavement adapts well to most traffic conditions.

The coating of the pavement contributes to increasing the structural capacity by reducing the impact of the weight that is transmitted to the underlying layers (foundation, sub-foundation and ground). It also limits water penetration. Layering variable thicknesses of different materials, such as sand, gravel, and crushed stone, also counters the effect of frost on the ground. The useful life of flexible pavement prior to major renovations is generally between 25 and 30 years. The thickness and types of materials used are determined based on the type of road that is being constructed, traffic, characteristics of the soils, and the specific climatic conditions.

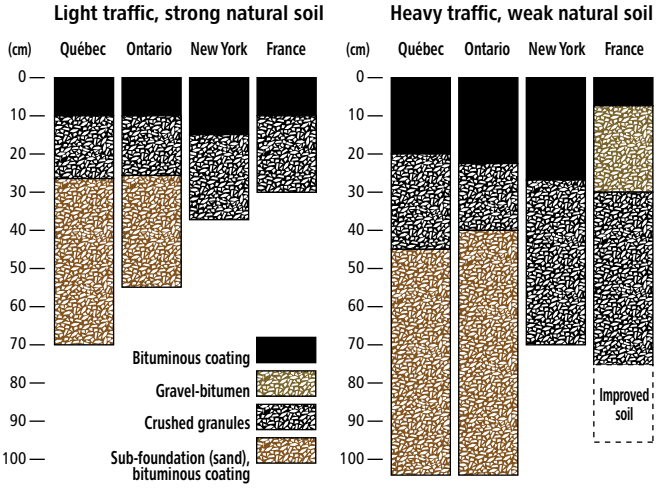
The design method provides for the use of a series of equations, with factors that are adapted to the Québec context, taking into consideration the following elements:

- Climatic conditions (temperature, humidity). The thaw period is critical: the same truck axle can cause 5 to 8 times more damage in spring than in summer.
- The susceptibility to frost and thaw, and the mechanical properties of the soils at the site.

Once the calculations have been carried out, the loads and deformation that are liable to be transmitted to each layer are compared to the bearing capacity of each layer.

Heavy loads on thin layers or poorly resistant materials can cause premature cracks in the surface or permanent deformations in the pavement. For example, a 20% increase in load translates into a more than 100% increase in damage, which is why it is important to design the roadway properly and to accurately anticipate the evolution of the traffic.

The effect of frost on the pavement can cause swelling, which directly affects the quality of driving and reduces the pavement life cycle. An adequate thickness of materials, not too susceptible to frost, may be effective under such circumstances. The use of other pavement insulation techniques is sometimes necessary when the bearing soil deforms under the effect of frost. In the presence of heterogeneous bearing soils, the development of transitions is a common practice to ensure good pavement behaviour. Finally, the process is completed by analyzing the cost of the various options.



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- call 511 (in Québec) or 1-888-355-0511 (in North America).
- send an email to communications@transports.gouv.qc.ca.

Québec

3 PAVEMENT DESIGN

Changing practices

There are significant differences between roadway structures in different countries, which may seem surprising. However, these differences are inevitable, because the soil, the climate, the traffic, the materials used, and the costs are often very different. In light of this, comparison can be dangerous, as can importing technologies without conducting an in-depth analysis.

In Québec, the structure of pavement that is designed using proven design methods and parameters compare advantageously to that of other countries which are often cited as examples. Considering its unique context, and with equal traffic flow, Québec clearly ranks first in terms of the total thickness of the materials that make up its road structures.

Design methods and knowledge of pavement design are rapidly evolving, and new technologies and new products are emerging. In order to optimize the use of these new processes, and to reduce the risk of failure, the Ministère launched, in the 1990's, a meticulous monitoring program with respect to the performance of pavements, in order to document the evolution of the behaviour of pavements in the Québec context. This innovative approach has made it possible to establish a knowledge base for optimizing design methods and interventions on the road network. A number of pilot projects conducted by the Ministère, in collaboration with specialized companies, have made it possible to define the usage potential of various pavement construction and repair techniques. The development and increasingly common use of techniques including the recycling of roadway materials, and thermal insulation techniques for reducing the negative effects of frost on the behaviour of pavements are examples of these projects.

4 THE EFFECTS OF CLIMATE ON PAVEMENT

Although they may seem simple at first glance, roads represent structures that cover extensive expanses of land and exhibit complex behaviour. Understanding and analyzing this behaviour is one of the greatest challenges in civil engineering.

The personality of pavement

There are two main families of pavement, divided according to the type of coating used : bituminous-coated flexible pavement (asphalt), which makes up more than 90 % of the road network ; and rigid pavement with a concrete cement surface, which covers 4 % of the network. Figure 1 illustrates a cross-section of a roadway that can accommodate both types of structures. The choice of the most appropriate pavement type and design depends on a number of factors, including the anticipated intensity of traffic, the types of soil, the climate, the cost, and the local availability of construction materials.

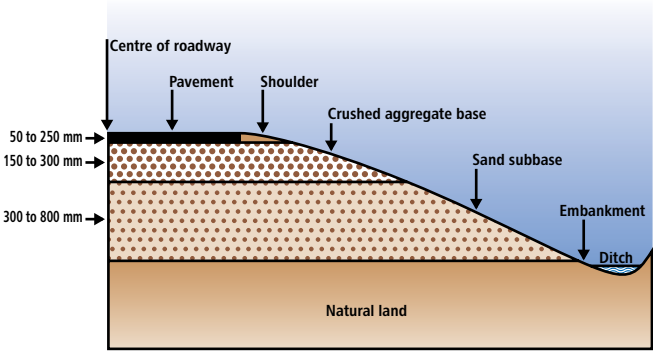

Figure 1 : Example of a typical pavement section

Working structures

The state of a pavement is evaluated according to certain defects that evolve over time and with wear. The following elements are often referred to in order to describe these defects :

1. Evenness, which is used to define the comfort of the ride, comprises defects that are perceived as waves due to their inherent peaks and valleys.

2. Ruts form, and the surface in the tire tracks weakens.

4 THE EFFECTS OF CLIMATE ON PAVEMENT

3. Cracking worsens, and other breaks appear on the surface.

Every pavement behaves differently, according to the nature of the underlying soil, the position of the water table, the thickness of the layers, the climate, the type and shape of the pavement, the characteristics of the construction materials, and traffic, among other factors. It is essential that all of these parameters be taken into consideration in order to adequately diagnose the causes of deterioration.

Understanding the phenomena of pavement deterioration makes it possible to find better solutions to counteract it.

In a Nordic land

Québec experiences temperature variances of 60° to 70° C. In fact, the temperature can drop as low as –30° C in winter, and rise above 30° C in summer. In winter, the ground freezes to a depth of between 1.2 and 3.0 metres, which is much thicker than roadway structures, which average 90 cm in thickness.

The following table compares the Québec context with that of Ontario, New York State, and France. Two important features emerge from this comparison : the harshness of the climate and the extensiveness of the Québec road network compared with the number of inhabitants.

State-managed road network : comparison between administrations

	Québec	Ontario	New York	France
Length of the road network (km)	30 600	21 100	24 100	20 000
Number of inhabitants (millions)	7.9	13.2	19.5	64.7
Average annual precipitation (mm)	1 000	850	750	800
Frost duration (days/year)	147 to 218	100 to 200	10 to 100	0 to 90
Frost depth (m)	1.2 to 3	1 to 3.2	Less than 1.4	0 to 0.8

4 THE EFFECTS OF CLIMATE ON PAVEMENT

Solutions adapted to the climate

Bitumen that is adapted to the climate must be used to prevent the coating from becoming too brittle in the winter and to allow it to remain sturdy enough in summer.

Drainage ditches along roads and the elevation of pavement represent means that are widely used to reduce the risk of the water table rising up to the road level. In some cases, it is necessary to install specific drainage devices, including gravel, synthetic membranes, or a closed drainage system that allows water to be expelled outside of the structure.

It is also often necessary to protect frost-susceptible soil by sheltering it from the cold. Accordingly, the thickness of the layers of sand and gravel on the northern roads is greater than on roads in warmer regions.

On occasion, deeper excavation is required in order to remove the problematic soil and replace it with soil that is less susceptible to frost. The soil is sometimes stabilized by means of a chemical product, such as lime. In certain cases, an insulated layer is inserted into the pavement in order to deter the penetration of frost. The insulating layers generally are composed of high-density polystyrenes.

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The use of certain devices or special products incurs additional costs, but makes it possible to generate substantial long-term savings. Therefore, these methods are only used if the financial gain that is attributable to the extended useful life of the pavement is beneficial in comparison with the initial investment.

Advantages and disadvantages of flexible pavements

With the effects of the cold, frost penetration occurs gradually from top to bottom in the soil (see Figure 2), and damages the structure. Under certain unfavourable conditions, the water in the unfrozen soil may be sucked into the frozen zone. This pumping of water from the water table results in the formation of ice lenses, which cause the pavement to heave.

Ice lenses in this soil sample appear as white areas

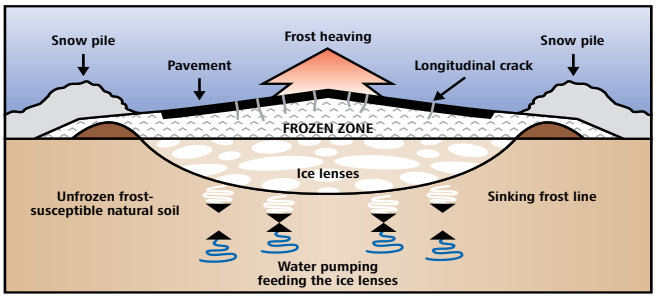


Figure 2: Effects of freeze/thaw cycles on a road

4 THE EFFECTS OF CLIMATE ON PAVEMENT

A) Frost heaving

Because of their size, these lenses can lift the pavement by as much as 20 cm. These frost heaves are often unequal, which explains the peaks and valleys that are more pronounced at the end of winter, when the frost depth is at its maximum.

This pavement is lifted by as much as 20 cm.

These lenses also have the effect of folding the pavement, which causes the appearance of frost cracks that are more or less longitudinal. Furthermore, like with any other material, the coating hardens, becomes brittle, and contracts under the effects of the cold. By shrinking over extended lengths, the coating is subjected to tension strains that cause it to break, which produces transversal cracks.

The pavement must endure even more after this point, because this is followed by the spring thaw, which also occurs from top to bottom. Large quantities of water from the melting snow on the surface and the melting ice lenses inside the roadway are found in the layer of thawed soil, weakening it significantly. The water is trapped in the ground as a result of the frozen bottom layer, which is sealed (see Figure 3).

Longitudinal cracking, as depicted in Figure 2

B) Weakening caused by thawing

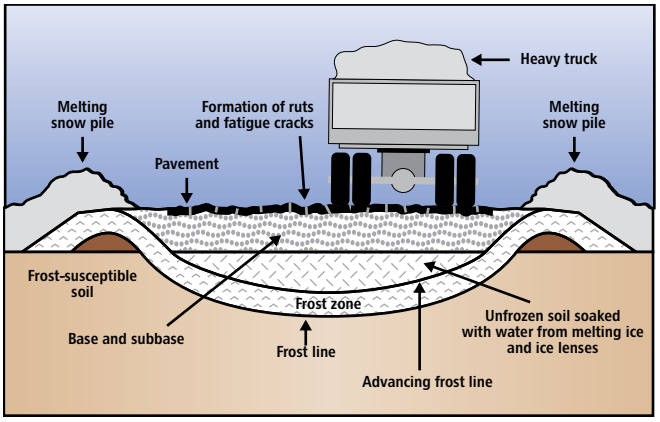


Figure 3: Effect of traffic during the thaw

As a result, the roadway retains only 30 % to 70 % of its normal summer resistance. Therefore, load restrictions must be imposed on heavy vehicles in order to limit damage during the thaw.

The roadway drains during the summer, and the cycle repeats itself every year, causing further deterioration. The damage accelerates over time, because the appearance of small defects creates additional zones of weakness, which allows more water to penetrate. These zones worsen and propagate more quickly over time. As a result, life in the north is far from relaxing, even for pavement.

5 REGULATIONS GOVERNING LOADS

The Vehicle Load and Size Limits Regulation specifies the various load limits according to the classes of axles (weight per axle) and classes of vehicles (total load mass), among other things. The main purpose of this Regulation is to prevent the premature deterioration of road infrastructures that can be caused by vehicles carrying excessive loads.

Regulations governing vehicle loads and sizes must take into consideration not only the costs and economic benefits, but also constraints related to road safety and the environment. We must not ignore the fact that load limits directly affect the number of vehicles on the road and the choice of transportation mode.

The economic importance of transportation

With the globalization of markets, Québec industries must become increasingly competitive. Transportation costs represent a significant portion of the total production cost of a manufactured product. Furthermore, in order to enable Québec to remain competitive, the ministère des Transports, de la Mobilité durable et de l'Électrification des transports must provide infrastructures that facilitate the transport of goods at the lowest possible cost. Among all of the available modes, road transport remains the uncontested preference among a significant number of shippers, primarily because of its flexibility, speed, and competitive costs. However, shippers and carriers who opt for trucking must deal with constraints in terms of authorized weight limits.

It has been demonstrated that higher weight limits would result in more rapid deterioration of the road network, but would boost the economy. On the other hand, lower weight limits make it possible to decrease the costs associated with maintaining the road network, but are harmful to several economic sectors. In light of this, it is essential to find a balance between the two positions.

Major trade corridors

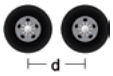
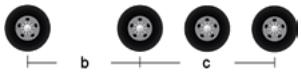
Maritimes – Québec – Ontario – Midwest

Québec – New England

Québec – New York

5 REGULATIONS GOVERNING LOADS

TABLE 1 : Axle Load Limit

Class of axles			Period		Reduction
			Normal	Thaw	
B.10	Single axle		10 000 kg	8 000 kg	20 %
B.21	Tandem	 d ≥ 1.2 m	18 000 kg	15 500 kg	14 %
B.33	Tridem or tridem equivalent	 3.6 m ≤ d ≤ 3.7 m	26 000 kg[1]	22 000 kg[1]	15 %
B.45	A self-steering axle in front of a tridem[2]	 2.5 < b ≤ 3.0 m 3.6 m ≤ c ≤ 3.7 m	34 000 kg	29 500 kg	13 %

[1] The limit is reduced by 1 000 kg in the case of a tridem equivalent.

[2] This class of axles must be equipped with a suspension system designed to distribute the mass evenly among all axles, within about 1 000 kg, and without possible adjustment.

TABLE 2 : Total Loaded Mass Limits

Class of vehicles or combinations of vehicles	Period		Reduction
	Normal	Thaw	
	25 250 kg	22 750 kg	10 %
	41 500 kg	36 500 kg	12 %
	49 500 kg	43 000 kg	13 %
	57 500 kg	50 500 kg	12 %
	62 500 kg	57 500 kg	8 %

5 REGULATIONS GOVERNING LOADS

Method for establishing the *axle load*

The maximum load authorized for a class of axles is the smallest of the following three values:

- The sum of the capacity of all tires (indicated on the side of the tire by the manufacturer);
- The load capacity of the front axle;
- The load limit stipulated in the Regulation according to the class of axles. This limit varies depending on the period (normal or thaw).

Method for establishing the *total loaded mass*

The total loaded mass that is established for road vehicles and combinations of road vehicles is the smaller of the following two values:

- The sum of the maximum loads authorized for each axle class. This limit varies depending on the period (normal or thaw);
- The total loaded mass limit for the class of road vehicles or combinations of road vehicles, as stipulated in the Regulation.

Decreasing load limits

Over the past two decades, load limits for heavy vehicles have been reduced by an average of 2 000 kg for most vehicles with three or more axles. These reductions, which were born of a desire to harmonize standards, to promote top-performing vehicles in terms of road safety, and to protect the road network, were introduced gradually in 1991, 1995, 1998, 2002, 2006 and 2010. Several types of vehicles have been targeted by these major weight reductions, and the limits are now lower than they have ever been. For example, the total loaded mass for a vehicle with a dumping mechanism and 10 wheels dropped from 28 500 kg to 25 250 kg, which represents a decrease of 3 250 kg, or 11.4 %.

Data from trucking surveys indicates that only 9 % of vehicles drive with the authorized maximum load. In other cases, vehicles drive with either no load, a partial load, or a load that is restricted by volume.

Other jurisdictions

As a general rule, the standards that are applied by neighbouring jurisdictions tend to influence each other. In fact, the load limits in Québec are either comparable to or more severe than those that apply in other Canadian jurisdictions.

6 DETERMINATION OF THE THAW PERIOD IN QUÉBEC

In Québec, the thaw period falls between November and mid-March. Around mid-March, an incipient warming of the air temperature is generally observed. During this transition period, the pavements begin to thaw, from their surface downward, on days when atmospheric temperatures exceed the freezing point, at the same time that long hours of sunlight are observed.

During this spring thaw period, the load limits that are permitted for heavy vehicles are reduced to protect the road network, which has a lower bearing capacity. The Vehicle Load and Size Limits Regulation specifies the applicable restrictions. These load reductions are around 8% to 20%, depending on the class of axle.

Some milestones in the history of the thaw period

The first provisions concerning thaw period load restrictions date back to 1955. The regulation governing heavy traffic on certain roads of the province was then adopted under the Motor Vehicles Act. This Act empowered the Minister of Roads to determine 50% load reductions in thaw or rainy periods.

Then, beginning in 1968, the ministère des Transports, de la Mobilité durable et de l'Électrification des transports undertook to monitor the evolution of the thaw period more methodically, through the use of probes placed in the pavement and commonly known as "frost depth probes" or "frost tubes".

The start and end dates of the thaw period have been recorded systematically since 1977, as evidenced by the table entitled "Thaw history – 1977-2016".

Determination of thaw zones and dates

Since 1991, Québec has been divided into three thaw zones, where the start and end of the load restriction period are slightly staggered over time. This division of Québec's territory into three zones was established by accounting for the geographic realities, the usual frost depth and the thaw trend in the different regions, the spring climate conditions and the traffic of heavy vehicles in the east-west axis.

Until very recently, the Ministère used over 90 frost depth probes, dispersed throughout Québec, to monitor the freeze/thaw progression and determine the start and end dates of the thaw period. The Ministère's personnel working in the regions were responsible for reading the frost/thaw depths in the frost depth probes at specified time intervals. This information made it possible to determine the start and end dates of the load restriction period.

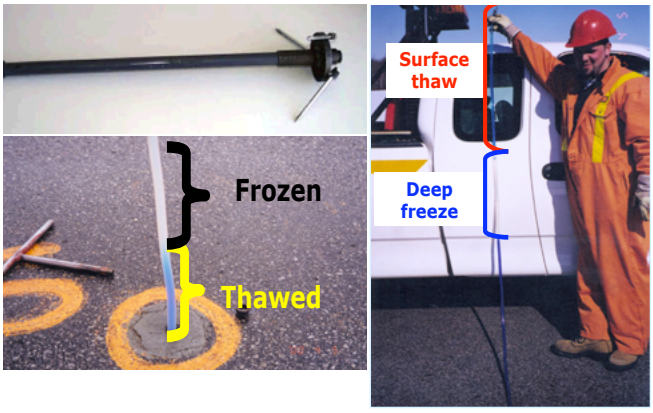


Figure 1 : Frost depth probe – Reading a frost depth probe

For further information, please:
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- send an email to communications@transports.gouv.qc.ca.

Québec

6 DETERMINATION OF THE THAW PERIOD IN QUÉBEC

Since winter 2014-2015, the freeze/thaw progression in pavements has been monitored with temperature data collected at the road weather stations, which have technology that allows fully automated monitoring.

The establishment of the load restriction period as such depends on the thaw depths calculated with the road weather stations data and analysis of weather forecasts.

The start of the load restriction period is determined by considering the extent of the thaw observed on a given date. The extent of the thaw represents the proportion of the stations indicating a thaw depth of 30 cm. The start of the load restriction period is established when the extent of the thaw reaches at least 30%.

The end of the load restriction period in a zone is fixed 5 weeks after the thaw depth in 50% of the stations has reached 90 cm.

In accordance with section 419 of the Highway Safety Code, the Minister of Transport, Sustainable Mobility and Transportation Electrification, by order published in the *Gazette officielle du Québec*, establishes the dates and zones where the restrictions are applicable.

Road weather stations to measure the frost and thaw depths

More than 50 road weather stations (RWS) are installed on the road network to collect the meteorological data affecting winter driving and pavement behaviour. The stations (Figure 4) are equipped with atmospheric sensors, pavement sensors and a 3-metre-long electronic probe buried in the base of the roadway.

The information provided is necessary for various aspects related to winter maintenance, frost and thaw monitoring, and pavement design. The sensors and probes installed in the roadways continuously read the following information:

- Sensors: surface characteristics, such as humidity, presence of ice, snow, liquid or ice depth, salinity, temperature.
- Electronic frost depth probe (Figures 2 and 3): captures the temperature at different depths for the freeze/thaw calculation in the pavements.

The purpose of this information is to:

- favour safe winter driving by motorists. The information characterizing the condition of the surface allows adaption of maintenance interventions on the network;
- allow frost and thaw monitoring in the pavements, and thus determine the load restriction periods during the thaw;
- allow measurement of the influence of climate change and evaluate the effects of heavy traffic on pavement behaviour.

The continuous operation of this equipment is essential to winter and spring management of the road network.

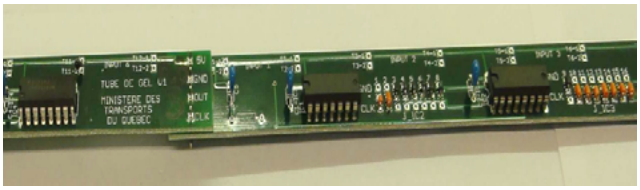

Figure 2: Overview of printed circuits of the electronic frost depth probe

Figure 3: Electronic frost depth probe

6 DETERMINATION OF THE THAW PERIOD IN QUÉBEC

Figure 4: Road weather station

Evolution of the thaw in the pavement

The load restriction period is divided into two phases:

- The first phase is the effective thawing of the soil, from the surface down to the lower strata. During this phase, the road's bearing capacity is reduced considerably. Indeed, the water produced in the soil during melting is then trapped by the underlying soil layers, which are still frozen.

- Then comes the pavement resistance recovery phase, which continues after the soil is thawed completely. The recovery necessitates the discharge of the quantities of water produced during the thaw.

The ambient temperature strongly influences the evolution of the first phase of the thaw, which essentially corresponds to the first weeks of the load restriction period. However, the temperature has less effect on the duration of the second phase, recovery.

Comparison with other jurisdictions

Most Canadian jurisdictions provide for load restrictions on their network during the thaw period. Similarly, nineteen States in the northern United States also imposed the same type of restrictions. The majority of the jurisdictions that have thaw period load restrictions do not impose any load restriction on their main highway system, exept for overloaded vehicles. Only Québec provides for such limitations on all public roads.

Québec justifies its position by:

- the frost depth, which is very extensive;
- the aging of its road network;
- the difficulty of controlling loads on the secondary network and the municipal network.

Reassessment of load restrictions

Québec proceeded with a complete reassessment of the thaw issue at the request of the Québec industry (carriers and shippers) and other Canadian jurisdictions. This reexamination shows that:

- the costs borne by the industry due to thaw period load restrictions are in the same order as the additional road network maintenance costs that would result from lifting the load restrictions;

- the imposition of thaw period load restrictions is therefore fully justified and a partial lifting of the restrictions that would apply only to the main network is difficult to envision;

- the ministère des Transports, de la Mobilité durable et de l'Électrification des transports is aware of the inconveniences caused by thaw period load restrictions. However, it must ensure optimum protection of roadways weakened during the thaw period, so that this collective property is maintained in good condition.

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Québec

7 LOAD RESTRICTIONS DURING THE THAW PERIOD

In winter, climatic conditions in Québec are particularly harsh. Depending on the region, the ground freezes to a depth of between 1.2 and 3 metres for more than 4 months. Combined with sudden changes in temperature and humidity, this freezing has a significant impact on the behaviour of pavements. The freeze/thaw cycles also contribute to making pavements more vulnerable.

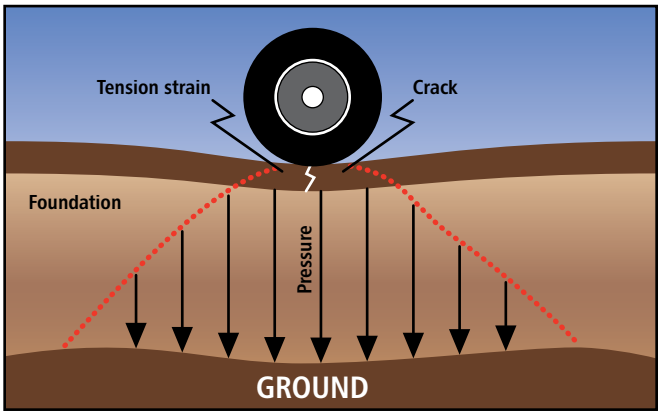

Figure 1 : Reaction of pavement under the load

In spring, the layers of materials that make up the pavement are weakened by the accumulation of water caused by melting ice. Studies conducted by the Ministère pertaining to the bearing capacity of roads have demonstrated that the reactions of the pavement under a load at this time are 50 % to 70 % more pronounced than those recorded during the summer.

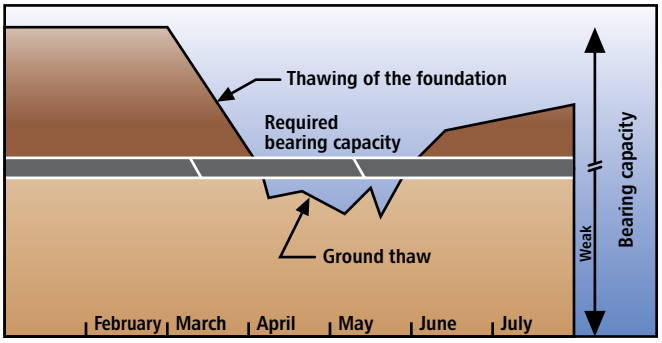

Figure 2 : Evolution of the bearing capacity of pavements

At any time during the year, a vehicle that is overloaded by 25 % will cause a corresponding increase in damage on the order of 150 %. During the thaw period, this phenomenon is intensified, and the same load on an axle can cause a tension strain that is 5 to 8 times higher than during normal periods.

Therefore, the impact of heavy transport during the thaw period is greater, due to the fact that the number of commercial vehicles has increased significantly over the years. For this reason, *the Vehicle Load and Size Limits Regulation* requires carriers to lighten their loads.

These restrictions are not necessarily meant to slow the appearance of surface damage such as potholes, but rather to prevent the deterioration of the structure of the pavement, which often results in permanent deformation and a loss of quality of the evenness.

During the thaw period, roads are 30 % to 70 % more fragile than during normal periods, and a single overloaded truck can cause major damage.

In order to minimize the deterioration of pavement during this period, the ministère des Transports, de la Mobilité durable et de l'Électrification des transports subjects road carriers to more restrictive regulations with respect to the weight of their vehicles.

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Québec

8 ROAD CHECKS

The compliance of loads carried by heavy vehicles is verified by officers from Contrôle routier Québec, which reports to the Société de l'assurance automobile du Québec. For these 300 traffic controllers, who are distributed throughout Québec, the thaw period represents an intensive period of weighing operations. To accomplish their work, they can rely on 34 road check stations and over 700 portable scales.

In an effort to prevent accident risk and adequately protect the road network, the controllers apply a strict compliance policy. Therefore, in keeping with this approach, any vehicle that is overloaded or that presents a risk, is not permitted to resume its journey until it complies with the regulations. If a truck is overloaded, the trucker must distribute the load over the axles or unload the excess weight before the truck can resume its journey.

An overloaded truck not only damages the road network, but its road behaviour is altered, making it less safe. It is essential to comply with the vehicle load limit in order to ensure the safety of all road users, and to protect the road network.

In the context of their mandate, which entails improving the safety of road users, ensuring the protection of the road network, and promoting competitive equity among transportation businesses, traffic controllers apply the 10 laws and 28 regulations that govern the road transportation of people and goods, including the following :

- The Highway Safety Code ;
- The Act respecting owners, operators and drivers of heavy vehicles ;
- The various laws governing road transportation ;
- The Fuel Tax Act ;
- The Environment Quality Act ;
- The Criminal Code.

ROAD CHECK STATIONS AND LOCATIONS

Baie Saint-Paul	138 East
Boucherville	20 West
Brossard	10 West
Témiscouata-sur-le-Lac	85 North
Chambord	169 South
Cookshire-Eaton	108 West
Laval	13 South
Laval	25 South
Saint-Sulpice	40 West
Les Cèdres	20 East
Lévis	20 West
Lévis	73 North
L'Islet	20 East
Litchfield	148 East
Lochaber	50 East
Lochaber	148 West
New Richmond	132 East
Pointe-Lebel	138 East
Québec	73 South
Rouyn-Noranda	101 North
Saguenay	175 North
Saguenay	175 South
Saint-Augustin-de-Desmaures	40 East
Saint-Augustin-de-Desmaures	40 West
Saint-Bernard-de-Lacolle	15 North
Saint-Célestin	55 North
Saint-Étienne-des-Grès	55 South
Saint-Mathieu-de-Beloeil	20 East
Sherbrooke	112 East
Stoneham-et-Tewkesbury	175 North
Trois-Pistoles	132 East
Trois-Rivières	40 East
Val-d'Or	117 South
Vaudreuil-Dorion	40 East

In addition to the road check stations, the traffic controllers use approximately thirty control areas, which are secure sites where heavy vehicles are inspected. These control areas are located throughout Québec.

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Québec

8 ROAD CHECKS

Some statistics

- In addition to heavy vehicles registered in Québec, traffic controllers annually inspect approximately 9 500 vehicles used to transport people and goods that are registered in another province or state.

- Over the past four years, Contrôle routier Québec has checked the weight of:
  - 2.3 million vehicles;
  - 290 000 combinations of heavy vehicles.

- The overall authorized mass compliance rate for trucks is approximately 96 %. During the thaw period, this percentage drops to 75 %.

This drop in the compliance rate during the thaw period can be explained by the imposition of additional load restrictions. This situation has resulted in a certain number of truckers adopting the habit of transporting a partial load or a volume-restricted load, thereby ensuring that their loads are within the authorized limit. As a result, the percentage of trucks carrying the authorized maximum load increases by 20 % during the thaw period.

During the 2015 thaw period, Contrôle routier Québec performed nearly 18 000 interventions, which detected more than 2 200 violations pertaining to overloaded axles or excess total mass. Over 50 % of the detected offences involved overloaded axles.

FREQUENTLY ASKED QUESTIONS : PAVEMENTS

1. What types of bituminous coatings (asphalt) are used on Québec roads?

Bituminous coatings are generally composed of several layers that contain different types of asphalt. There are many combinations of bituminous mixtures, but there are approximately ten that are more commonly used, depending on the purpose of the layer. The "base" normally consists of a more granular mixture that has excellent structural qualities. The mixtures that are used for the surface must provide characteristics that ensure adequate skid resistance, driving comfort, and increased resistance to wear.

2. Where do potholes come from, and how are they formed?

Potholes represent the final step in a series of surface deterioration phenomena on a pavement.

Events occur in the following sequence :

- Appearance of cracks, which may have been caused by a number of factors, including intense traffic, the freeze/thaw cycle, production defects, etc. ;
- Deterioration of the cracks due to a concentration of constraints under the effect of traffic, and the appearance of multiple cracks ;
- Infiltration of water and brine, which contributes to a reduction in the bearing capacity of the foundation and the acceleration of the deterioration process ;
- The freeze/thaw cycle accelerates the deterioration ;
- The effects of traffic : dynamic impacts, the number of vehicles, and the severity of the phenomena described above are all factors that determine the rate at which potholes appear.

A computer simulation on the Ministère's website clearly illustrates the phenomena that lead to the formation of a pothole.

3. Given the climatic conditions in Québec, is it possible to avoid the appearance of potholes?

Generally speaking, the formation of a pothole is closely related to the state of the pavement. Therefore, the risk of a pothole appearing is related to the degree of cracking of the coating, traffic use, and the amount of water that is liable to penetrate beneath the coating. Maintenance work to keep the pavement in good condition is the best way to prevent the formation of potholes.

In light of this, it is possible to prevent the appearance of potholes if pavements are adapted to local weather conditions, if they are not subjected to a more intense traffic condition than they were designed for, and if it is possible to maintain them adequately within the necessary timelines.

It is important to remember that the restrictions that are placed on the loads carried by heavy vehicles during the thaw period are not intended to ensure the protection of the driving surface, which is affected by all vehicles (for example, a road in a residential district where heavy trucks do not drive may be covered in potholes), but rather to preserve the actual structure of the road.

4. What is the life expectancy of a "cold asphalt" repair compared with a "hot asphalt" repair?

Repairs made using cold asphalt are generally carried out as an emergency measure. The primary purpose of these repairs is to ensure user safety. The lifespan of this work is generally less than one year, and it is often necessary to implement corrective measures during the summer. This is why the use of hot asphalt is strongly recommended during the winter.

FREQUENTLY ASKED QUESTIONS : PAVEMENTS

No matter what the season, it is important to follow good repair practices, which entails drying the crack or hole and installing an anchoring binding. By following this procedure, it is possible to ensure that the repair will enjoy a maximum life span of between 2 and 5 years. Repair work that is carried out during the summer generally lasts the longest.

A technical newsletter that is published by the Direction du laboratoire des chaussées deals specifically with this topic. It can be consulted online on the Ministère's website.

5. How long is a repair to the top layer of the coating (driving surface) expected to last ?

The useful life of a 40 to 50 mm thick asphalt coating for pavement that actually supports the traffic that it was designed for, and for high traffic roads (national highways and freeways), varies between 9 and 14 years. For roads that are used less, or on which the maximum speed limit is lower, the expected lifespan of the surface is approximately 15 years. For the most part, these data correspond to the generally accepted standard for a road surface repair.

Furthermore, considering the fact that traffic flow has a direct impact on the useful life of pavement, the service demand on the road network administered by the ministère des Transports, de la Mobilité durable et de l'Électrification des transports is evaluated every year. Traffic data are collected, processed, analyzed and validated. Updating the databank makes it possible to anticipate the evolution of the condition of the road network.

6. Given the climatic conditions in Québec, how is it possible to improve the condition of highways and roads ?

It is essential to establish intervention strategies throughout the network and to set specific objectives, in order to be able to effectively improve the quality of roads.

Nevertheless, the optimization of interventions throughout the network requires a prior knowledge of the specific condition of the roads, in order to determine what work is most appropriate. Once it is compiled in a road management system, all of this information makes it possible to establish the performance of the various maintenance scenarios in accordance with the allocated budgets, and to make short-, medium-, and long-term projections for the attainment of upgrading objectives.

Improving the quality of interventions also involves the use of materials that are adapted to traffic wear and climatic conditions. The steps involved in the design and a meticulous approach to the achievement of the work also represent determining factors that promote the longevity of repair and maintenance interventions.

7. Why does the quality of roads vary so much within a region ?

Each level of jurisdiction, from municipalities to the Ministère, is responsible for maintaining its road network. As such, each jurisdiction determines its objectives and manages its budgets according to these objectives. In general, the need for maintenance work relates to the age and level of use of the network, which sometimes varies considerably from one location to another.

FREQUENTLY ASKED QUESTIONS : PAVEMENTS

A significant portion of the extensive primary road network, which is the responsibility of the ministère des Transports, de la Mobilité durable et de l'Électrification des transports, was built in the 1960s and 1970s. Several segments, which are also more heavily used than the municipal network, are currently in need of major repairs. In the current context, where maintenance needs for the aging primary network are significant, the primary objective of the Ministère is to ensure and improve safety for road users. Therefore, an intervention to fix ruts that may cause aquaplaning will be favoured over an intervention aimed at improving comfort.

The Ministère closely monitors the evolution of the conditions of the road network in accordance with the amounts allocated for its preservation. By acting in this manner, Québec taxpayers are ensured that their investments will be optimized.

8. Does the ministère des Transports, de la Mobilité durable et de l'Électrification des transports conduct research in the areas of technologies or innovation of components?

The Ministère is very active in research and development as it pertains to new ways of contributing to improving its activities involving the road network. For example, since the early 1990s, the Ministère has been monitoring the performance of specific work carried out on segments that are deemed to be representative of its road network. This approach will enable it to evaluate the potential for using various techniques and products, or to validate their application. The following is a list of research projects that were conducted by the Ministère that made it possible to improve the quality of work pertaining to pavements :

- Research pertaining to bitumen and asphalt, which made it possible to establish the criteria for choosing asphalt according to the climatic conditions that are found in Québec. This work leads to the maximized performance of bituminous asphalt ;
- Reusing materials from the demolition of roadways. This practice is used in major projects, especially in the Greater Montréal Area. Concrete elements such as slabs, curbs, bases for light standards, etc. are crushed and reused as aggregates. These aggregates are used to manufacture sub-layers for the reconstruction of pavements. Several thousand tonnes of materials have been reused since 1998. This approach is in keeping with the objectives of the ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, and those of the ministère des Transports, de la Mobilité durable et de l'Électrification des transports, in terms of recycled materials and reducing the impact of work on the environment ;
- The use of a thermal insulator on sections of the road network where major problems related to frost have been reported. The use of insulators, which was done on an experimental basis only a few years ago, has now become a proven, reliable, and economical technique for providing definitive solutions to some specific contexts, and has even been adopted as a standard;
- The recycling of bituminous coatings during pavement repairs, which began in the 1990's, is now a common practice in both urban and rural settings. Accordingly, more than 2 000 km of roads in the Ministère's network have been repaired using this technique. This work, which is carried out in a variety of contexts, has clearly demonstrated the performance and profitability of this approach.

FREQUENTLY ASKED QUESTIONS : PAVEMENTS

9. How is it possible that a Nordic land like Québec has not yet refined a recipe for "high performance" asphalt ?

In the first place, it is important to mention that "indestructible asphalt" does not exist anywhere in the world. Nevertheless, Québec has recorded significant gains in the field of asphalt over the past 15 years. In fact, the ministère des Transports, de la Mobilité durable et de l'Électrification des transports has participated in major North-American research projects that have made it possible to refine new methods for designing bituminous mixtures that are better adapted to our climatic context.

Work that has been carried out by the Ministère, in collaboration with various research organizations, including universities, has also made it possible to significantly improve roadway design methods. Better designed roads offer better resistance to the onset of heavy traffic, and are less vulnerable to the effects of freezing and thawing.

The Ministère has also contributed to the development of roadway assessment methods. This research has made it possible to develop new equipment for evaluating the bearing capacity of roads, and to automatically measure the cracking and evenness of roads. These methods, which are more reliable and more productive, allow for more precise results and diagnoses, which in turn lead to better adapted intervention choices.

10. What steps does the Ministère take during the construction of a new road ?

The execution of a road project by the ministère des Transports, de la Mobilité durable et de l'Électrification des transports represents the culmination of several months of sustained study, collaboration, and discussion among numerous participating stakeholders. From the moment when the opportunity study is tabled until the request for proposals documents are accepted, the project manager must plan and organize consultations, and request studies, surveys, authorizations, acquisitions, and the relocation of obstacles that are located inside the rights-of-way.

Roadway design requires that the following elements be taken into consideration, among others :

- The geological, hydric, and geotechnical context of the site that has been selected for the work ;
- The anticipated level of traffic and the local climatic characteristics ;
- The choice of materials. Economic analyses of the various options under consideration make it possible to make an informed choice in order to attain the targeted quality objectives ;
- The insulation of pavements, the calculation of the reuse of fill, urban drainage (lane sizing, location of drainage grids), the relocation of public services as required, etc.

The Ministère's *Guide de préparation des projets routiers*, which is intended mainly for technical personnel, is the reference tool pertaining to this topic. The Guide reviews the activities that are most often carried out during the project preparation process.

The Guide can be consulted online on the Ministère's website.

FREQUENTLY ASKED QUESTIONS: VEHICLE LOADS

1. Are authorized load limits in Québec higher than elsewhere?

Authorized load limits in Québec are comparable to those of neighbouring authorities. In recent years, Québec has made considerable efforts to harmonize its load limits with those that are in effect among its commercial partners.

Over the past two decades, load limits have been reduced by an average of 2 000 kg for most vehicles with three or more axles. The purpose of these significant reductions is to protect road infrastructures and to improve safety for all road users.

2. Considering the increase in heavy vehicle traffic in recent years, can the Québec road network adequately support this additional demand?

Road structures are designed to withstand a certain level of use. In other words, they must be able to support a foreseeable amount of vehicle traffic, including trucks, over a given period of time before the road requires total or partial reconstruction. Therefore, the useful life of a road depends on whether or not the anticipated number of trips has been attained.

A faster than anticipated increase in traffic will result in a faster than anticipated deterioration of the roadway, which will decrease its longevity. Lower than anticipated use will have the opposite effect.

Therefore, a level of use that differs from the scenarios that were considered at the outset will affect the evolution of the network. We are aware that not all Québec roadways are designed to respond to the traffic that we are experiencing today, and this influences the behaviour of these roads. In light of this, the Ministère has acquired road monitoring and management tools, and has implemented intervention strategies aimed at ensuring the longevity of existing structures.

3. Why are special permits issued?

If the size of a vehicle or the load exceeds those that are permitted pursuant to *the Vehicle Load and Size Limits Regulation*, a special traffic permit must be obtained. The *Regulation respecting special permits* establishes the conditions that must be respected by a vehicle that is outsized due to its manufacture or indivisible load. There are 7 classes and 2 categories of special permits.

4. Would decreasing load limits reduce the damage caused to the road network?

Decreasing load limits during normal periods and during the thaw period would certainly reduce the amount of damage caused to the road network. The cost of maintaining the network would likely decrease significantly. However, the economic impact of reducing load limits for the industry would be detrimental to the Québec economy.

Transport costs are directly related to authorized load limits. An increase in transport costs would make our exported products less attractive on foreign markets. For the most part, existing authorized load limits are harmonized with our main economic partners. Variances in this area would create additional trade constraints.

In addition, decreasing load limits would result in an increase in the number of vehicles, which would not necessarily be beneficial to the road network or to the environment. An increase in the number of heavy vehicles could also have an effect on road safety.

FREQUENTLY ASKED QUESTIONS: VEHICLE LOADS

5. During the thaw period, roads are 30% to 70% more fragile than during normal periods, so why are load reduction only 8% to 20%?

Damage to the road network is caused by several factors. Among these factors, the load under the wheels of a heavy vehicle has a huge influence. The relationship between the load and the damage is not linear, but rather exponential, which means that a slight overload will have a significant effect on the damage that may be caused to a road network. For example, a 20% overload on a single axle causes twice as much damage to the road as a legal load on the same axle. Conversely, a slight decrease in the authorized load results in a significant decrease in its effect on the road network. Therefore, a 20% reduction corresponds to a reduction in damage of approximately 60% compared to an axle that bears a legal load. Load reductions that are applicable during the thaw period have been staggered in order to maximize the protection of the road network while ensuring that economic activity in sustained.

6. Why is Québec divided into three load restriction zones during the thaw period?

The thaw zones were established by taking into consideration differences in the frost depth, which varies considerably from north to south, the progress of the thaw, the climatic conditions that are prevalent in the various regions of Québec during the spring, the geographic characteristics of the province, and heavy vehicle traffic in the east-west corridor.

Obviously, it would be possible to increase the number of zones in order to take into consideration the microclimate specific to a given area to a higher degree. By doing so, the duration of the period of load restrictions in each zone could be reduced. However, inter-zone truck transport would become very constricting, which would severely restrict mobility.

FREQUENTLY ASKED QUESTIONS: VEHICLE LOADS

7. Why are the weigh stations that are located along the roads not open 24 hours per day all year long?

Check stations are operated according to a sporadic opening strategy, depending on the season, the days of the week, the time, the type of transportation and the class of roads where the check station is located.

Example
In the thaw period, depending on the traffic flow of the road where they are located, the check stations are open 4 to 8 hours a day, on the average. Some of them can remain open up to 24 hours a day, according to a synchronism that accounts for the neighbouring check stations. This approach ensures optimum coverage of the main road corridors. Contrôle routier Québec also relies on a mixed strategy, including both interventions at fixed stations and mobile interventions, particularly by creating temporary control areas.

8. Why not favour other transportation modes?

The gouvernement du Québec favours intermodal transportation. This is why, over the past few years, it has deployed measures to support the various transportation modes. It is possible to obtain information by consulting the "Assistance programs" page of the Ministère's website at www.transports.gouv.qc.ca.

However, many businesses rely on trucking in order to satisfy their needs for the transport of goods. They do this for a multitude of reasons, including the flexibility, speed and competitive costs of this transportation mode. Many businesses also apply the just-in-time method, which controls the logistics chain rigorously, a practice well suited to trucking.

Not all types of goods can be taken over interchangeably by the marine or rail transportation sectors. An optimistic estimate assesses at 6 % the number of truck trips in Québec that could be taken over by another transportation mode.

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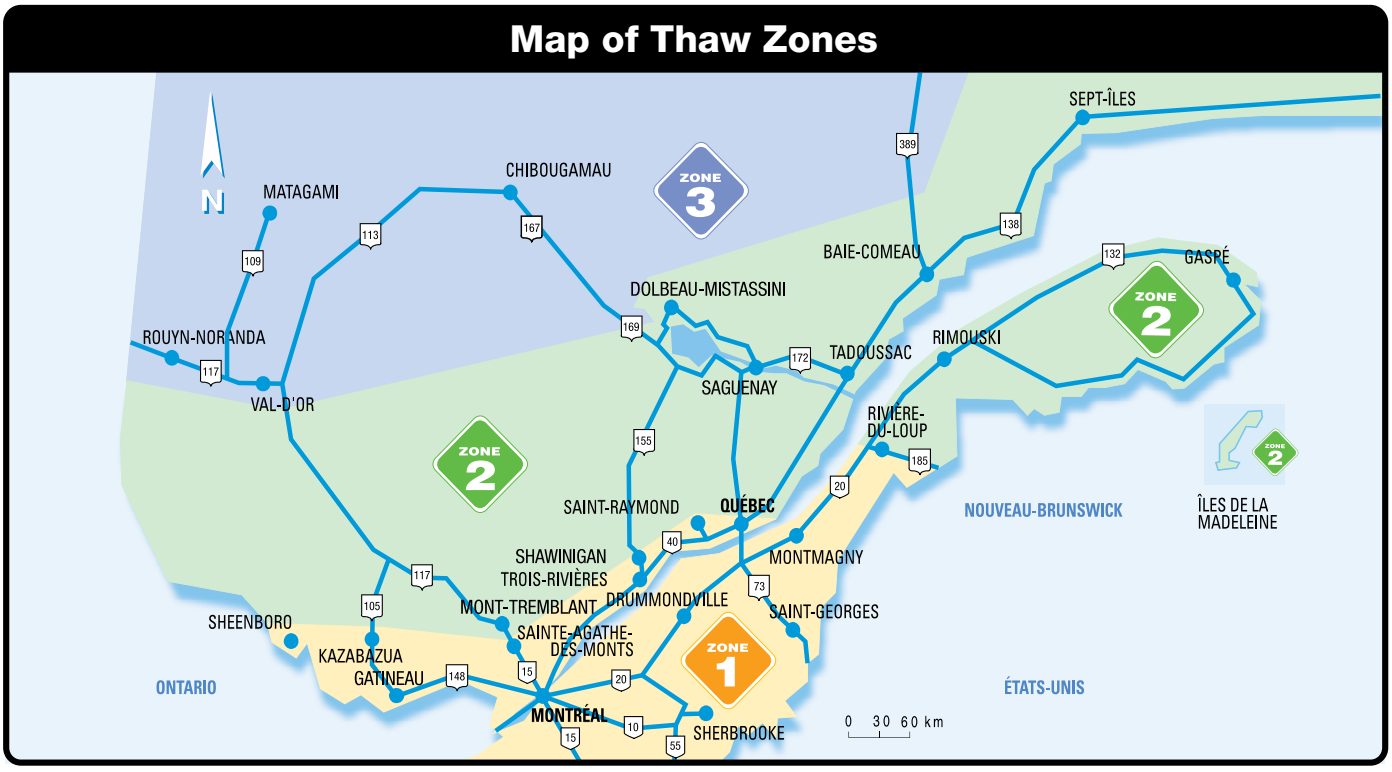
Québec

THAW ZONES IN QUÉBEC

Map of Thaw Zones



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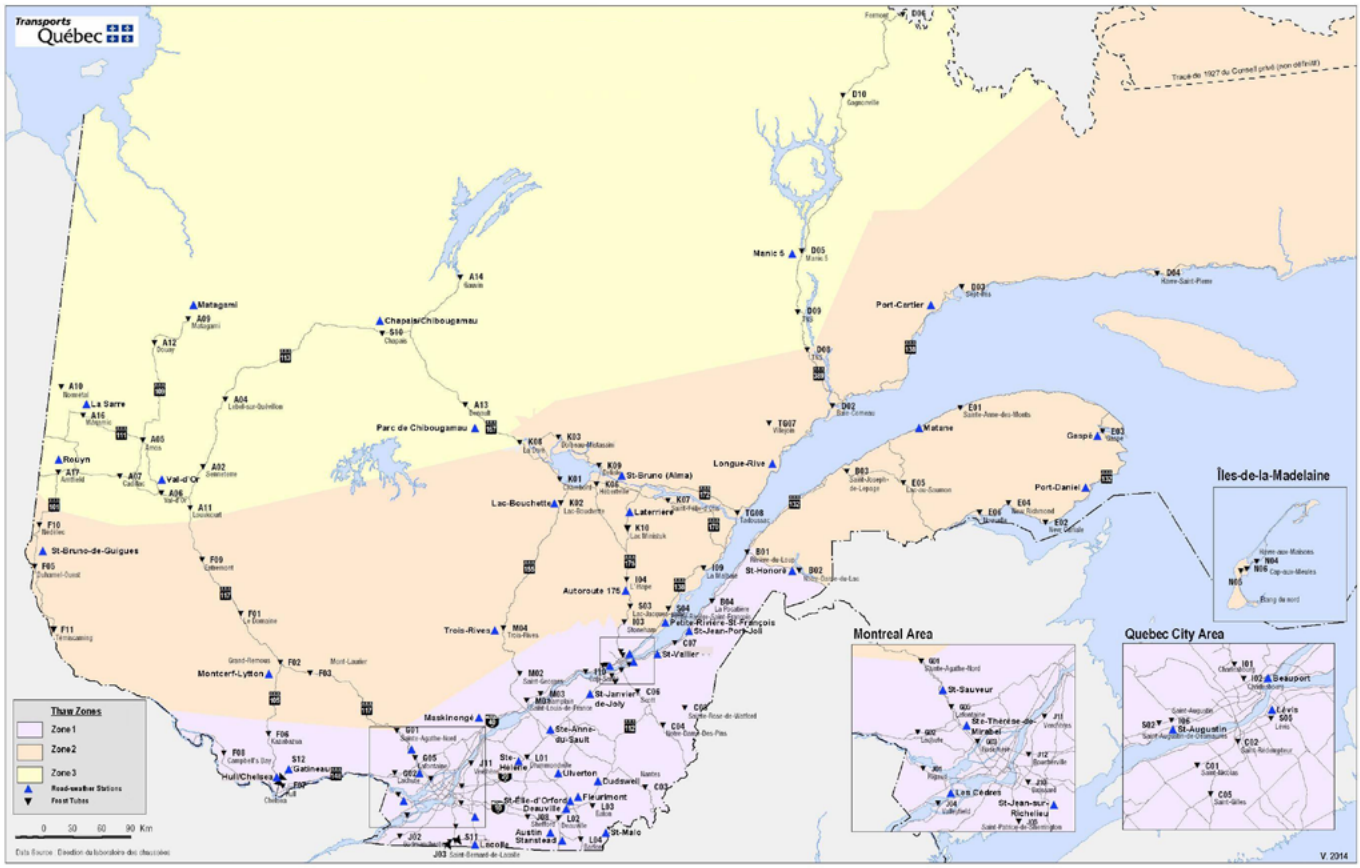
Québec

LOCATION OF ROAD WEATHER STATIONS AND FROST PROBES



Map of road weather stations and frost probes (May 2013

For further information, please:

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Québec

THAW HISTORY
1977 - 1990

YEAR	ZONE 1			ZONE 2		
	START	END	DURATION	START	END	DURATION
1977	27 March	15 May	49 days	3 April	15 May	42 days
1978	27 March	21 May	55 days	3 April	21 May	48 days
1979	26 March	21 May	56 days	2 April	21 May	49 days
1980	24 March	12 May	49 days	31 March	19 May	49 days
1981	25 February	4 May	68 days	25 February	19 March	64 days
	–	–	–	30 March	11 May	
1982	22 March	17 May	56 days	29 March	24 May	56 days
1983	14 March	2 May	49 days	21 March	16 May	56 days
1984	25 February	1 March	54 days	–	–	–
	26 March	14 May		2 April	21 May	49 days
1985	18 March	13 May	56 days	2 April	26 May	54 days
1986	14 March	9 May	56 days	1 April	19 May	48 days
1987	23 March	4 May	42 days	26 March	11 May	46 days
1988	20 March	9 May	50 days	31 March	16 May	46 days
1989	20 March	13 May	54 days	31 March	20 May	50 days
1990	13 March	12 May	60 days	19 March	24 May	66 days

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THAW HISTORY
1991 - 2016

YEAR	ZONE 1			ZONE 2			ZONE 3		
	START	END	DURATION	START	END	DURATION	START	END	DURATION
1991	13 March	10 May	58 days	20 March	17 May	58 days	28 March	25 May	58 days
1992	13 March	10 May	58 days	20 March	17 May	58 days	28 March	25 May	58 days
1993	13 March	10 May	58 days	20 March	17 May	58 days	28 March	25 May	58 days
1994	13 March	10 May	58 days	20 March	17 May	58 days	28 March	25 May	58 days
1995	13 March	10 May	58 days	20 March	17 May	58 days	22 March	29 May	68 days
1996	15 March	12 May	58 days	21 March	19 May	59 days	24 March	25 May	62 days
1997	15 March	12 May	58 days	21 March	19 May	59 days	24 March	25 May	62 days
1998	5 March	5 May	61 days	5 March	12 May	68 days	24 March	17 May	54 days
1999	21 March	6 May	46 days	21 March	15 May	55 days	24 March	25 May	62 days
2000	6 March	12 May	67 days	21 March	19 May	59 days	24 March	25 May	62 days
2001	12 March	16 May	65 days	19 March	16 May	58 days	26 March	21 May	56 days
2002	11 March	11 May	61 days	18 March	18 May	61 days	25 March	25 May	61 days
2003	21 March	17 May	57 days	24 March	24 May	61 days	31 March	31 May	61 days
2004	15 March	15 May	61 days	22 March	22 May	61 days	29 March	29 May	61 days
2005	21 March	15 May	55 days	28 March	21 May	54 days	4 April	21 May	47 days
2006	20 March	15 May	56 days	27 March	15 May	49 days	27 March	22 May	56 days
2007	15 March	15 May	61 days	19 March	19 May	61 days	26 March	26 May	61 days
2008	24 March	24 May	61 days	31 March	24 May	54 days	31 March	24 May	54 days
2009	16 March	9 May	54 days	23 March	16 May	54 days	30 March	23 May	54 days
2010	8 March	17 April	41 days	8 March	24 April	48 days	15 March	9 May	56 days
2011	21 March	13 May	54 days	21 March	20 May	61 days	28 March	27 May	61 days
2012	5 March	27 April	54 days	12 March	11 May	61 days	19 March	11 May	54 days
2013	11 March	10 May	61 days	18 March	17 May	61 days	25 March	31 May	68 days
2014	31 March	23 May	54 days	7 April	30 May	54 days	7 April	30 May	54 days
2015	30 March	22 May	54 days	6 April	29 May	54 days	6 April	5 June	61 days
2016	14 March	13 May	61 days	21 March	27 May	68 days	28 March	3 June	68 days

* The starting and ending dates of the load restriction period may be adjusted depending on weather conditions.

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THE ROAD SIGN DISPLAY

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