Curriculum resource, updated 2023

Section 3: Connecting ideas

3.1. Taking care and keeping safe around trucks

Learning area: Mathematics and statistics

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Read the following facts and information about crashes involving trucks on New Zealand's roads.

Trucks and road crashes

When truck drivers drive the big rigs carrying goods and materials across New Zealand, they have an important professional role in the New Zealand economy. They belong and matter to our community, and they make a difference to the lives of all New Zealanders.

However, the size of the trucks on our roads brings special safety challenges for pedestrians, cyclists, other drivers and their passengers who are sharing the road with them. So truck drivers have tight rules to make sure they stay alert when driving – to protect them from driver fatigue. These regulations set out the total number of kilometres they can drive in a day, the total number of hours they can drive in a day and when they must take breaks from driving.

Driver fatigue (Waka Kotahi)

Identifying and preventing driver fatigue (commercial driving, Waka Kotahi)

Even with these safety measures in place, the larger size and mass of trucks makes their involvement in crashes more serious.

The Government records statistics about road crashes involving trucks. For example, deaths from crashes involving trucks range from 18-25 percent of the annual total road toll during 2011 to 2021.

The number of fatal truck crashes per 100 million km travelled by trucks trended downward from the turn of the century and has been flatter in the past 10 years.

Safety – Annual statistics: Trucks (Ministry of Transport)

Around a third of heavy vehicle crashes in New Zealand involve a rollover – which is when a vehicle overturns while moving. We have a high incidence of such crashes for distance travelled compared with the USA and Canada.

This is in part due to the challenging road conditions in New Zealand. We have many bridges, corners and hills per 100 kilometres of road, and fewer divided highways in other developed countries.

Rollover can happen when you're going too fast for a curve in the road, your loaded vehicle has poor stability or the load shifts or moves within your vehicle during the journey.

Preventing rollover (Waka Kotahi)

Stability (Heavy vehicle road code)

Statistics reported by the media show that in 2014, trucks were involved in 23 percent of all fatal crashes and 7 percent of all reported injuries on roads, but only responsible for 35 percent of the fatal crashes. Other motorists often make the mistakes that contribute to the crash.

Trucks rarely to blame in fatality crashes (NZ Herald)

Tasks

1. Describe the percentage of crashes in New Zealand involving trucks.

How has this changed over time?

2. Draw a pie chart showing the proportion of truck crashes in which the truck driver was at fault.

3. Explain why we have a high incidence of truck rollover crashes. Suggest measures that might help reduce the incidence of truck rollover crashes in New Zealand.

4. Make a generalisation about our next steps for making journeys safer in view of the statistics showing that other drivers sharing the road with truck drivers often cause truck crashes.

3.2. Mass matters

Learning areas: Mathematics and statistics, Science

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Use your science and mathematics understanding to think about and experiment with the following facts and information.

Trucks, mass, and crashes

The rate of serious crashes involving trucks is in many cases due to the large mass of any truck driving on a New Zealand road. Mass is a measure of how much matter (stuff) is in an object. It is measured in kilograms (kg).

Trucks are to New Zealand road vehicles what the great whales are to mammals, the hippopotamus is to even-toed ungulates, and the polar bear is to land carnivores. They are all much larger in mass and size than the others in their group.

Being much taller, longer and heavier makes a difference when objects change their state of motion, slow down, speed up, change direction or experience a collision impact.

Being much taller and longer makes a big difference to what you can and cannot see on the road around you.

Being much larger and heavier makes a big difference to the impact when crashes happen.

Trucks are bigger (have a larger mass) than most other vehicles sharing New Zealand roads. The heavier or faster the object, the more energy it contains.

The science of larger mass and velocity tells us that in any crash with a lighter vehicle, a cyclist or a pedestrian, it is the road user with the smaller mass who is more likely to experience stopping forces that lead to serious injury or death.

How changes to a truck's mass or velocity affect crash risk and effects The mass and velocity (speed in a certain direction) of a moving truck affect: • truck braking • truck cornering • impact (damage) in a crash.		
Braking	**Cornering**	**Impact**
When the velocity is unchanged: A heavier truck goes further before stopping.	When the velocity is unchanged: a heavier truck has a greater overturning (side) force as it enters the corner.	When the velocity is unchanged: a heavier vehicle experiences greater damage (to the vehicle and its driver) on the point of impact, compared to a lighter vehicle experiencing the same impact.
When mass is unchanged: a faster vehicle goes further before stopping.	When mass is unchanged: a faster vehicle has a greater overturning (side) force as it enters the corner.	When mass is unchanged: a faster vehicle experiences greater damage (to the vehicle and the driver) at the point of impact, compared to a slower vehicle experiencing the same impact.
If you **double** the truck's velocity: it will take at least **four times** the distance to stop.	If you **double** the truck's velocity: there will be at least **four times** more overturning force on the truck.	If you **double** the truck's velocity: there will be at least **four times** more impact (energy release) in a collision with another object, vehicle or pedestrian.

Refer to:

Stability (Heavy vehicle road code)

Videos

Stopping distance

Truck Smart: stopping distance

Volvo Trucks – Emergency braking at its best!

Braking

Brake test: Modern truck vs. old truck

Volvo Trucks Automatic Emergency Brake System

Mercedes-Benz Actros - Active Brake Assist 4 and Sideguard Assist (2016)

Rollover

Crash testing Scania's new truck generation

Blind spots

Truck Driver's Blind-spot and Cycling

Safety Truck Video – Keep out of Truck Blind Spots

Jack-knife

Volvo Trucks – Increased safety on slippery roads with Volvo Trucks' Stretch Brake

Crash tests

How Semitrucks Are Crash Tested

Tasks

1. Define mass, distance, speed, velocity and their units.

2. Use model vehicles (toy trucks, trolleys, and marbles of different mass), metre rulers and deformable material to investigate the reliability and validity of the claims in the information box above. For example:

Compare and contrast the stopping distance of two vehicles with different mass but similar velocity (speed in a specified direction).

How are the stopping distances similar? How are they different?

Compare and contrast the damage done by (the impact of) two vehicles with different mass but similar velocity (speed in a specified direction).

How is the impact similar? How is it different?

3. Select an experiment or mathematical investigation from the suggestions below to determine:

- the total extent of the blind spots (areas) around different truck and truck trailer units
- the path of a truck and trailer unit through a left- or right-hand turn
- how the mass or velocity of a model truck/marble changes its stopping distance, its ability to corner or its impact when it collides with a fixed object.

4. Investigate and make models to show how and why a High Productivity Motor Vehicle **(**HPMV) can exceed a mass of 44,000kg and the maximum length dimensions allowed for standard vehicles, but meet the higher individual axle and axle group limits and be no wider or higher than a standard vehicle. Use your models to explain how HPMVs on the roads change the ways we should think about keeping safe around trucks. For example, use models to show why longer vehicles require more road space for turning.

High productivity motor vehicles (Waka Kotahi)

5. Explain how and why Waka Kotahi engineers set maximum allowable weights for trucks and HPMVs using the roads.

Explore how and why the gross weight of a truck is determined by its axle loadings.

Why can different axle types and tyre types carry heavier loads?

Identify the different ways truck designers arrange axles to maximise the load a truck can carry.

Make a 2-3 minute video using models to demonstrate these. In your video explain why the gross weight of a truck using the road network matters to road engineers and road users.

Vehicle dimensions and mass (Waka Kotahi)

The Development of Pro-Forma OverDimension Vehicle Parameters Research report which discusses axle loadings, axle spread and trucks' impact on bridges and roads.

About Road user charges (Waka Kotahi)

6. Share your new learning about how children can keep safe around trucks using one of the following products.

Advertisement, animation, art work, baking, board game, brochure, cake decoration, cartoon, carving, chart, comic book, computer game, cupcakes, dance, shop window display, drama, drawing, documentary, flyer, graph, game, haiku, “how to” guide, illustrated story, infographic, jingle, kete, letter, logo, mask, map, mime, montage, musical performance, mural, photo essay, pamphlet, performance, pick a path, postcards, poster, poem, puppet show, radio show, rap, recipe, role play, rubric, scrapbook, sculpture, slideshow, song, speech, t-shirt, television commercial, trading cards, video, whakataukī, web page.

Reflection on connecting ideas sessions

What do you know you don’t know about keeping safe around trucks?

What have you learnt that is new to you about keeping safe around trucks?

What do you wonder about keeping safe around trucks?

Use the student responses to make decisions about follow-up work.