Sway solution

Canadian Geographic's May/June 2017 issue highlights a Canadian technology that steadies skyscrapers when wind gusts surpass 100 km/h. The Guelph-based engineering firm RWDI has created damping systems that curb the swaying of skyscrapers on windy days. With your students, use the infographic and the following questions to explore this exciting concept and learn how the "tuned mass damper" (TMD) works.

Check for understanding

1. a) Other than a TMD, how can skyscraper movement caused by high winds be reduced?

   ____

   b) Why are these solutions less effective?

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2. a) What factors contribute to the potential for oscillations?

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   b) Explain how these factors affect the oscillations.

   ____

3. Explain and illustrate the features of a TMD that reduce swaying.

Answer (with sketches)

Sway solution

Extend your geographical thinking

1. **Be an architect**
   Part A: Locate the tallest structures in Canada. Choose a few and explore the landscape or cityscape around them by using Google Maps' Street View and the Internet. Make a table and note the following characteristics: the average wind speed, the look of the structure in comparison with those around it, natural disaster threats (e.g. earthquake, tornados, floods), and harsh weather conditions (e.g. high winds, hail storm). Discuss as a class how the structures were built to withstand the harsh weather and natural disasters.

   Part B: Choose a location in the world and explore it by using Google Maps' Street View. Find an empty space at the location where you could potentially build a tower. Design and build a tower by using only sheets of 8.5" by 11" paper and masking tape. The tower's design (colour, shape, height, etc.) should fit into the landscape or cityscape, and be suitable for the location's corresponding climate. Present your tower to the class and explain your design choices.

2. **Where in the world?**
   Research and make a list of the world's 10 tallest skyscrapers. Using Google My Maps, map out these buildings by adding markers on the map. Add text and pictures to explain the features of each building that allow them to withstand high winds. Be sure to include the average wind speed at roughly each location.

Resources

- RWDI's tuned mass dampers
- What is a Tuned Mass Damper?
- L.A. now has a new tallest building. How it will fit into the fabric of the city is still open to debate
- Windfinder
- Meet the giants of tomorrow: The tallest buildings rising in 2017
- A Kid's Guide to Building Great Communities: A Manual for Planners and Educators

Sway solution

The Canadian technology steadying the world's skyscrapers

By Nick Walker

By March, Toronto had already recorded two days in 2017 with 100 km/h winds. And when gusts that powerful buffet a city, there are condo owners and office workers who feel the sway. In some skyscrapers, the movement is imperceptible, but the worldwide trend of building ever higher and slenderer adds to the potential for oscillations of several centimetres on either side of centre. It's not dangerous, but it can be dizzying.

"Every building has a natural frequency in the wind," says Trevor Haskett, senior technical director and vibration control expert with Guelph-based engineering firm RWDI. "You can reduce the movement by altering aerodynamic form or adding mass, but that can be undesirable or costly."

Instead, developers from Manhattan and Chicago to Taipei and the Middle East are increasingly calling on RWDI to create damping systems that curb windy-day swinging. For buildings with long oscillations and limited space, a steel or concrete "tuned mass damper" (TMD) such as the one shown here, is often the best fit. Read on to find out how RWDI's massive, moving counterweights cut down skyscraper drift.

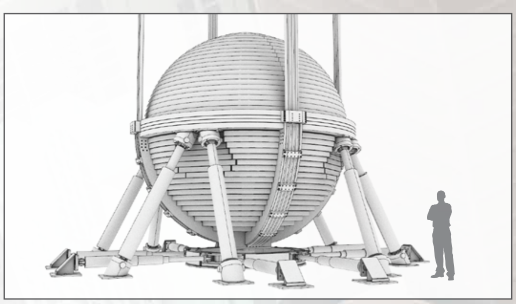
SWAY If this 325-metre concept building didn't have a damping system, a once-in-10-years windstorm with gusts of 150 km/h could rock its top more than 20 centimetres in each direction.

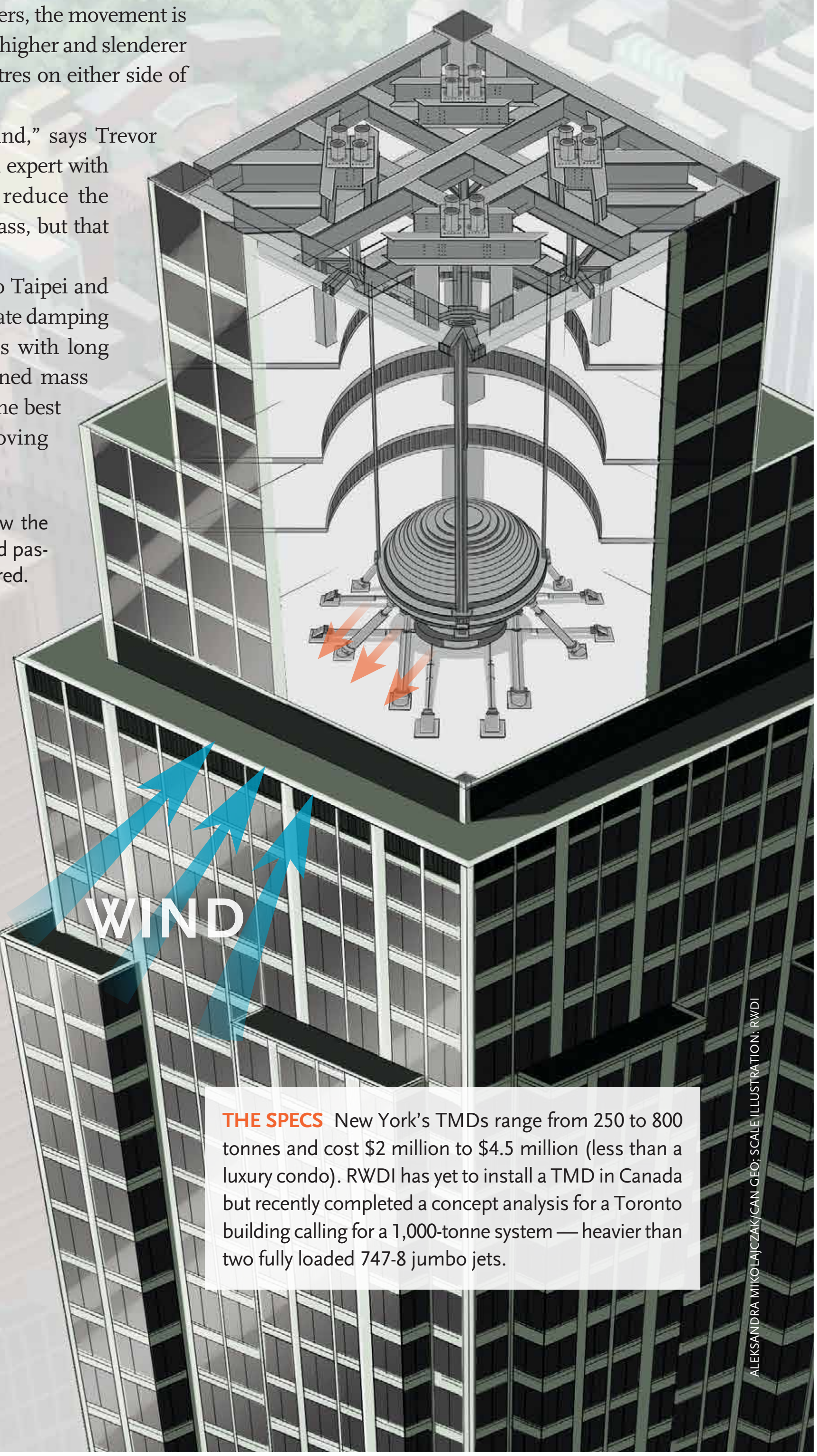
INSTALLATION Pistons, spring mounts and cables allow the TMD, mounted in the building's highest storeys, to respond passively to sway. No electricity or network connection is required.

TUNING TMDs are "tuned" to match a building's specific frequency of oscillation, countering the structure's energy with their own for the same period of time.

HOW IT WORKS When winds blow and the building drifts, the TMD shifts freely (in the opposite direction of each sway) pulling the tower back toward equilibrium and reducing the wind's effects by 40 to 50 per cent.

SHAPE Bigger sway, heavier counterweight — but *shape* depends on available space. The spherical steel TMD shown below is based on the 728-tonne design in Taipei 101, a 508-metre skyscraper. RWDI also designs huge sloshing liquid dampers.





THE SPECS New York's TMDs range from 250 to 800 tonnes and cost $2 million to $4.5 million (less than a luxury condo). RWDI has yet to install a TMD in Canada but recently completed a concept analysis for a Toronto building calling for a 1,000-tonne system — heavier than two fully loaded 747-8 jumbo jets.

ALEKSANDRA MIKOLAJCZAK/CAN GEO; SCALE ILLUSTRATION: RWDI

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