City Talk

The SEG Plaza swaying sends occupants and passers-by fleeing.

SOLVING THE WOBBLY SKYSCRAPER PUZZLE

Most of us live and work in tall buildings so when we hear about vibrations in skyscrapers, it sends a shiver down our spines.

The recent vibrations detected in the 71-story, 300-meter-tall SEG Plaza in Shenzhen not only caused concern to occupants, but also started many discussions here regarding vibrations and the ensuing safety issues they bring for tall buildings.

Engineers are aware that all buildings, although looking rigid, can sway in the face of high winds or other forces.

When a typhoon strikes, a building may sway up to hundreds of millimeters, and the occupants could experience discomfort, but they know that such vibrations are built into a building's design and accept it as a weather phenomenon.

A technical solution for dealing with excessive swaying in tall buildings caused by external forces would be to install tuned mass dampers.

The principle of its operation is that a heavy mass is suspended near the top of the building, and with a system of springs, this heavy mass will move like a pendulum, but in the opposite direction to the movement of the building to counter the forces induced, substantially reducing the amplitude of the swaying.

The mass and its movement are designed to maximize the counter force effect.

But in the case of SEG Plaza, it seems the vibrations were caused by resonance and not by excessive external forces.

All structures have their own natural frequencies.

When a structure is excited by a nearby source of similar frequency, like a tuning fork, resonance will occur.

The effect is that the structure may vibrate with ever-increasing amplitude, until the source goes away.

This phenomenon has often been observed in some large bridge crossings, but the same theory of physics applies to buildings too.

For SEG Plaza, such resonance has never occurred in the 20-plus years of its existence until now.

So, either there is a new source of excitation nearby or its structure's natural frequency has changed. It's even more puzzling to see nearby buildings not showing any similar phenomenon.

Some experts suspect the swaying was caused by running trains near its foundation. This is possible as trains are like heavy masses moving at a certain speed.

Unless effective "floating slab" designs were used to minimize the vibrations from train operations, this can be a source of excitation to nearby buildings.

With changing train schedules and loads, it could just be possible that a new combination could excite resonance in this building when its natural frequency matches.

Another possibility is that some parts of the building's structure could have been altered or even damaged due to renovations or overloading, thus altering its natural frequency.

That, so far, no damage has been observed in the building's facade should give occupants some reassurance that whatever caused the vibration may not be too serious.

Hopefully after thorough investigations and any necessary remedial work are completed, they can return to use it without fear of danger to life and property.

Buildings, like all infrastructure, must be designed and constructed to high safety standards. But more importantly, throughout its life, regular inspection will best ensure that it remains safe for occupants.

Veteran engineer Edmund Leung Kwong-ho casts an expert eye over Hong Kong's iconic infrastructure