

# Standing strong

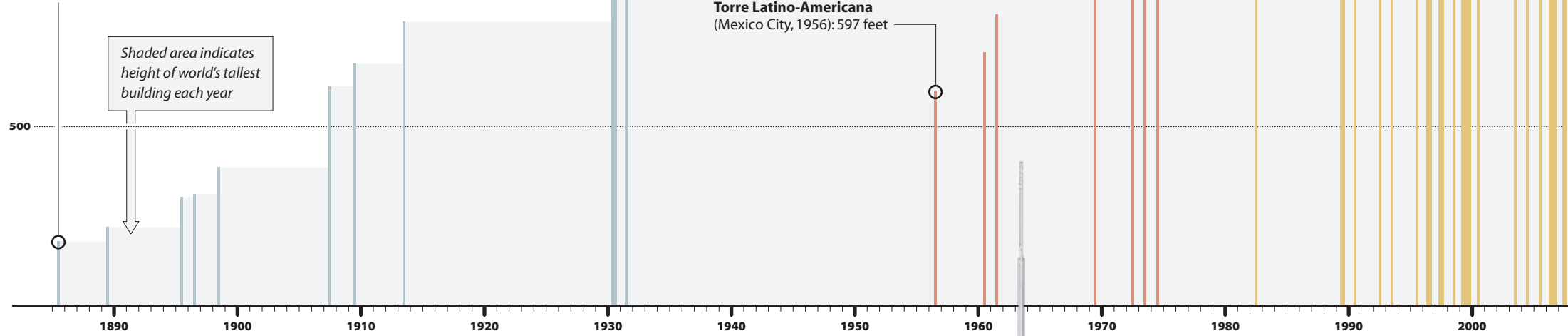
Since the world's first skyscrapers rose in Chicago in the 1880s, structural engineers have developed increasingly strong — and economical — methods for constructing architects' lofty visions. Chicago is currently home to three projects that exemplify the latest in skyscraper engineering.

## Growing up ... and up

Record-setting buildings within each structural generation (grouped by color), plus every building that exceeds 1,000 feet:



**Home Insurance Building (above)**  
(Chicago, 1885): with 1890 addition, 180 feet



## Evolution on the inside: Generational shifts in skyscraper engineering

### 1ST GENERATION PORTAL FRAME (1880s - 1930s)

The world's first tall office buildings were made of three-dimensional gridlike steel skeletons. Vertical columns connected to horizontal girders, allowing architects to increase the height of their creations without relying on thick load-bearing walls.



Girders

Columns were designed to resist wind forces.



AP photo

EXAMPLE: Empire State Building

### 2ND GENERATION FRAMED TUBE (1950s - 1970s)

Engineers in the 1950s and 1970s redirected the building's strength to tubes made of steel columns that surrounded the interior. Though more resistant to wind forces and more economical than portal frames, the new design sometimes limited the size of windows — and views — for occupants.



Tribune photo by Bill Hogan

EXAMPLE: Aon Center

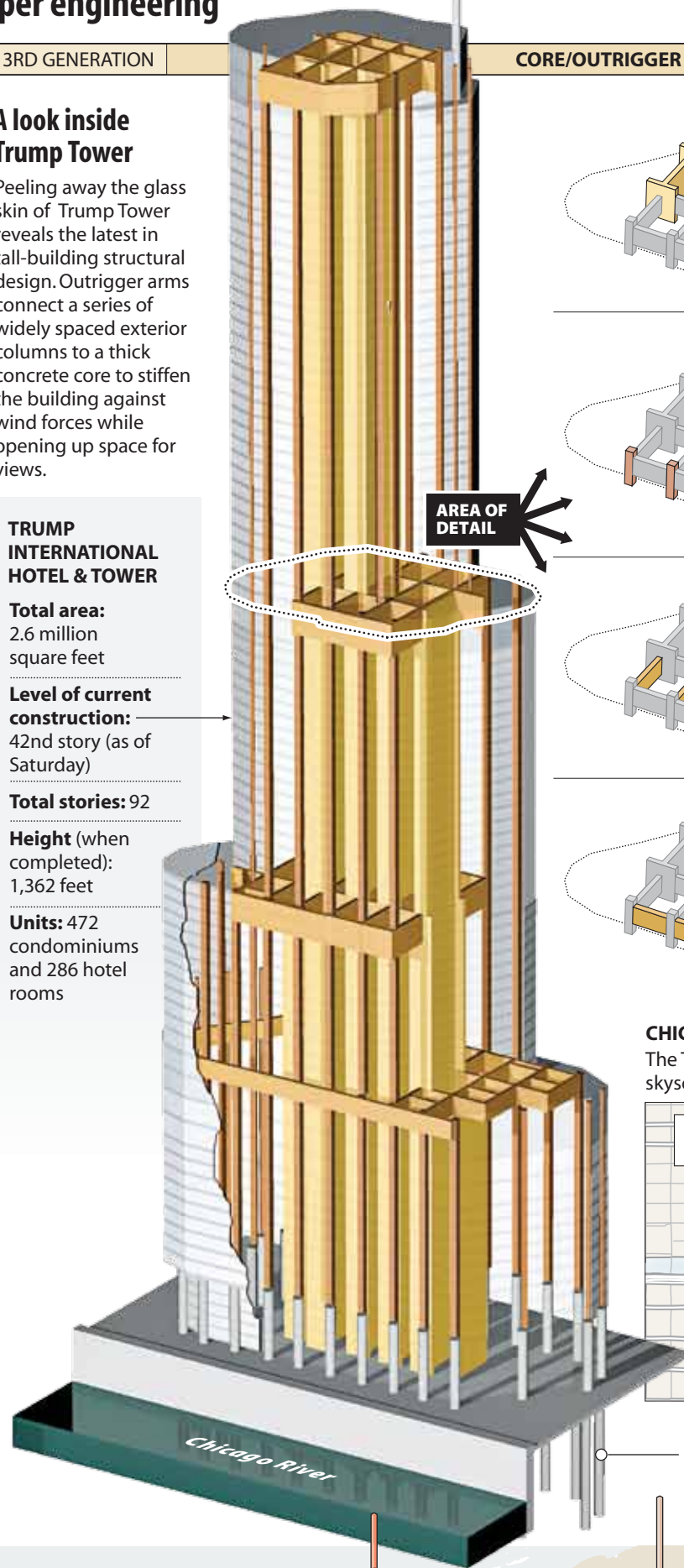
### 3RD GENERATION CORE/OUTRIGGER (since 1980s)

#### A look inside Trump Tower

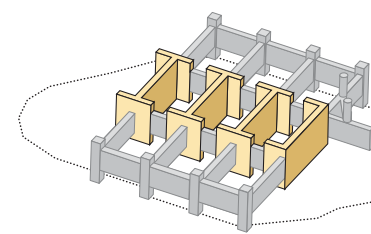
Peeling away the glass skin of Trump Tower reveals the latest in tall-building structural design. Outrigger arms connect a series of widely spaced exterior columns to a thick concrete core to stiffen the building against wind forces while opening up space for views.

#### TRUMP INTERNATIONAL HOTEL & TOWER

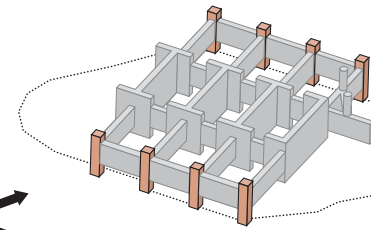
**Total area:** 2.6 million square feet  
**Level of current construction:** 42nd story (as of Saturday)  
**Total stories:** 92  
**Height (when completed):** 1,362 feet  
**Units:** 472 condominiums and 286 hotel rooms



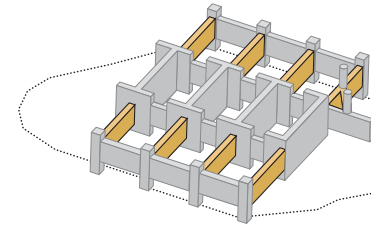
AREA OF DETAIL



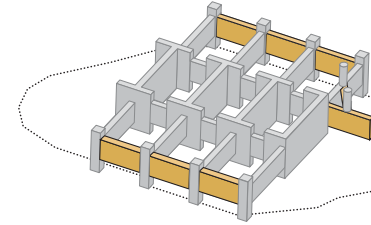
**Core:** A series of vertical walls shaped like I-beams with 4-foot thick ends house stairwells and elevator shafts.



**Concrete columns:** High-strength concrete columns become thinner as they rise and less support is needed.



**Outriggers:** 17 1/2-foot high concrete walls join the core to the columns, stabilizing against the wind.



**Belt walls:** Concrete walls connect the columns to increase stiffness.

#### CHICAGO'S LATEST SUPERTALLS

The Trump Tower is one of three supertall skyscrapers currently under construction.



**Caissons:** Reach down 110 feet to the bedrock, supporting the building's columns and core.

## Today's giants in progress

Once constructed almost solely in New York and Chicago as office buildings, supertall skyscrapers are now erected throughout the world as places for working and living. A look at 1,000-foot-plus buildings currently under construction illustrates a building boom in the Middle East and China.

#### KEY TO BUILDING USE:

- Residential and hotel (17 total)
- Office buildings (10 total)
- Mixed use (17 total)

(Height of each bar represents height of building when finished)

