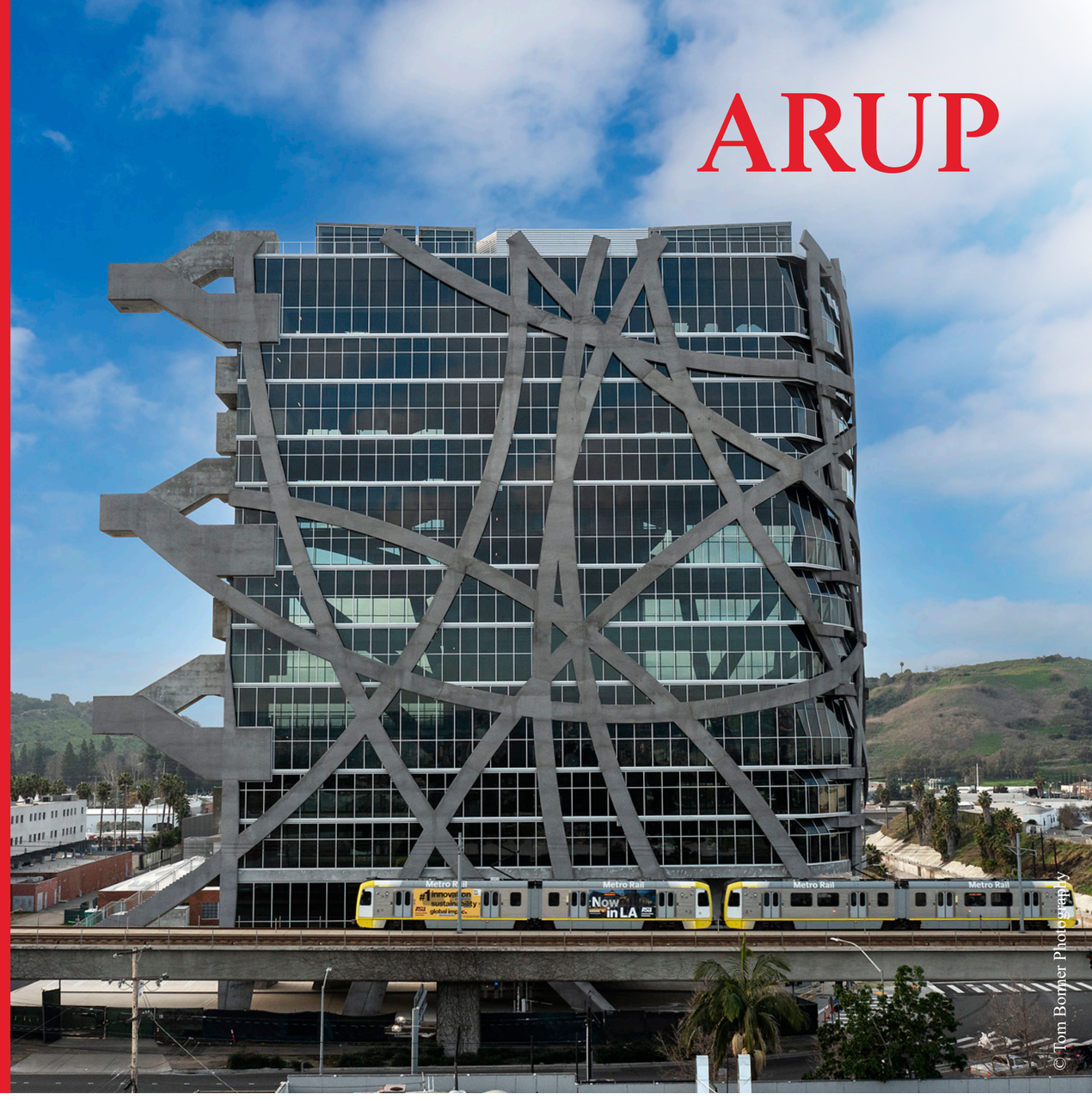
# (W)rapper

## Los Angeles, CA

Arup used a performance-based design approach and digital tools to analyze and design an unclassified, irregular, occupied sculpture in a high seismic region without any physical testing. At 235-feet tall and 180,000sf, (W)rapper is the only commercially available, base-isolated, office high-rise building in the country, and given its state-of-the art structural engineering, is one of the safest and most resilient office buildings in the world.

**Structural Engineer:** Arup
**Owner:** Samitaur Constructs
**Architect:** EOMA
**General Contractor:** MATT Construction
**Year of completion:** December 2022

ARUP



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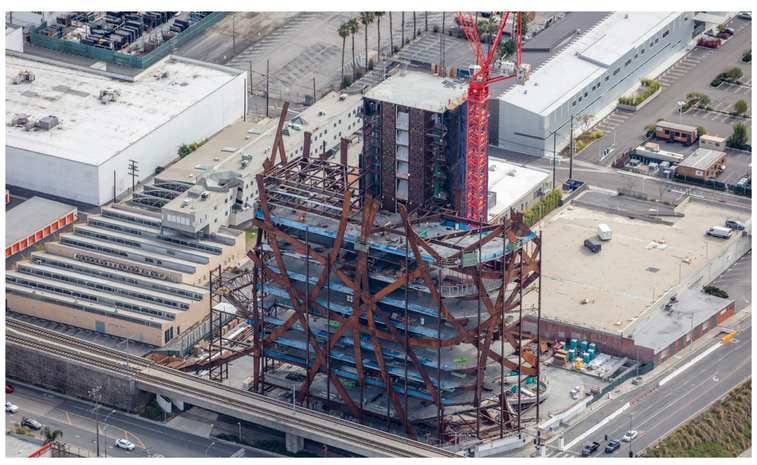
## The challenges

The primary vertical and lateral load carrying elements of (W)rapper specified by the architect are 5000’ of curvilinear, intersecting, 5’x1’ steel plate built-up boxes – the Bands. The other lateral load carrying element is a vertical transportation core placed outside of the floor plate. The Newport Inglewood fault is ~1/10mi from the site. How do you design an unclassified, irregular structure in a high seismic region without undergoing any physical testing?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**Unclassified, irregular structure**
5000’ of curvilinear, intersecting, steel plate built-up boxes – the Bands – wrap the building and form part of the lateral force resisting system.


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**Column-free, bespoke floor framing**
Primary framing spanning between the Bands differs at every level.


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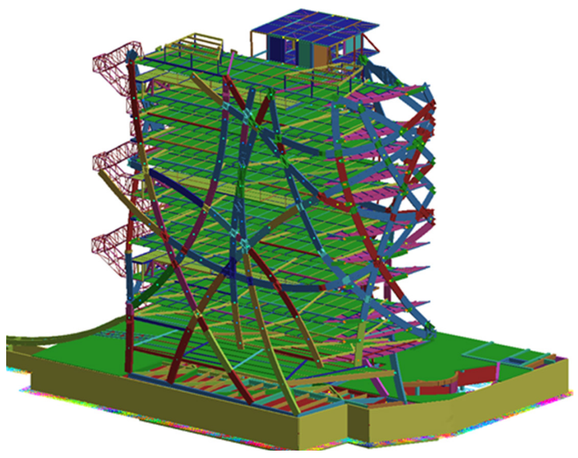
**Eccentric core**
The eccentricity and rigidity of the core located outside of the floor plate resulted in torsional irregularity.

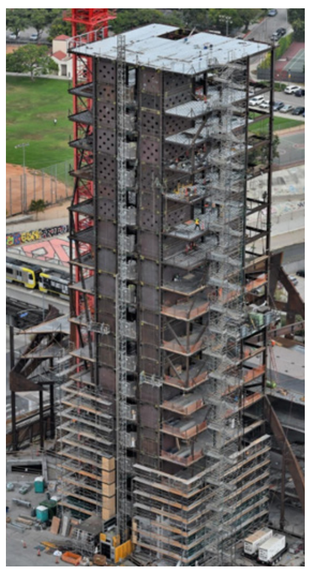
## The solutions

We worked with the Los Angeles Department of Building and Safety and the peer review panel to establish a performance-based approach to analyzing and designing the (W)rapper structure. Five critical solutions were employed to tackle the challenges:

1. Concrete core walls were changed from concrete to steel plate to lower the seismic mass and have one primary material subcontractor for the tower.
2. Base isolation was used between the tower and substructure to lower the seismic demand by a factor of four.
3. A high-fidelity global analysis model was used to capture the dynamic behavior of the building in an atypical software, LS-Dyna, that has a robust computational engine, typically used for car crash simulations, that could handle the multiple simultaneous nonlinearities.
4. The behavior of the unclassified Band structure undergoing dynamic loading was evaluated using finite element method shell models, saving millions and years on physical testing. We also worked with metallurgists at Exponent on material and weld fracture mechanics to confirm stability of the Bands
5. Development of an automated digital workflow and cloud computing was used to shorten the analysis and design time on the hi-fidelity structural model thereby making it a feasible design tool and process.



**Hi-Fidelity analysis model**
Every structural framing member was modelled in the nonlinear time history analysis model, over 100,000 elements.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**Perforated steel plate shear wall core**
Perforated and solid steel plate shear walls were wrapped around the vertical elevator cores as part of the lateral force resisting system.


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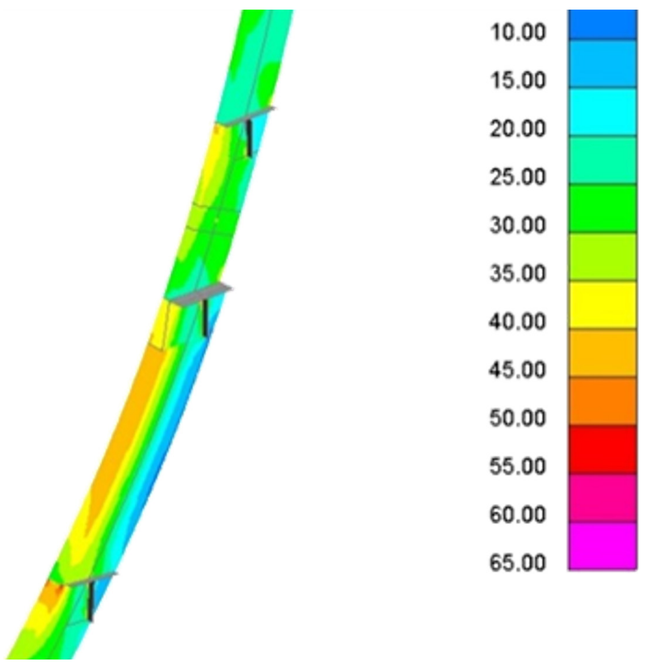
**Triple friction pendulum isolators**
20 TFP isolators are located below the 8 Bands that go to ground and the shear wall core columns.




**Band finite element analysis models**
FEA shell models, and material and weld fracture mechanics, were used to demonstrate acceptable behavior of the Bands during seismic events.


**Automated, cloud centric digital workflow**
We used an automated digital workflow to shrink the computational time of the Wrapper hi-fi analysis model from the industry norm of 2 weeks, to just 2 days. Automation was used to build and stitch together multiple, simultaneously generated structural element models, to run the analysis with multiple earthquake ground motion scenarios, to post process the >16TB of data and to query specific results for design of elements by a team of engineers.