

Evolving Technology for Design and Construction of More Efficient Concrete Structures

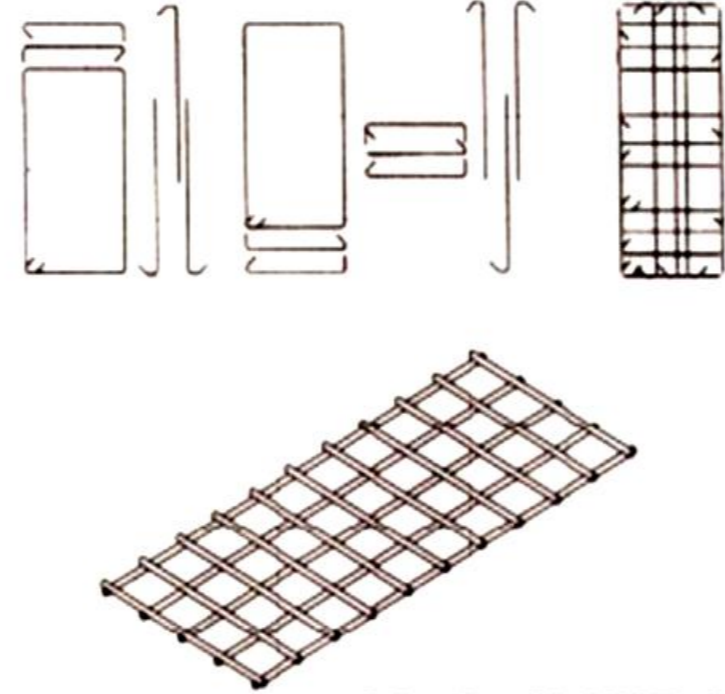
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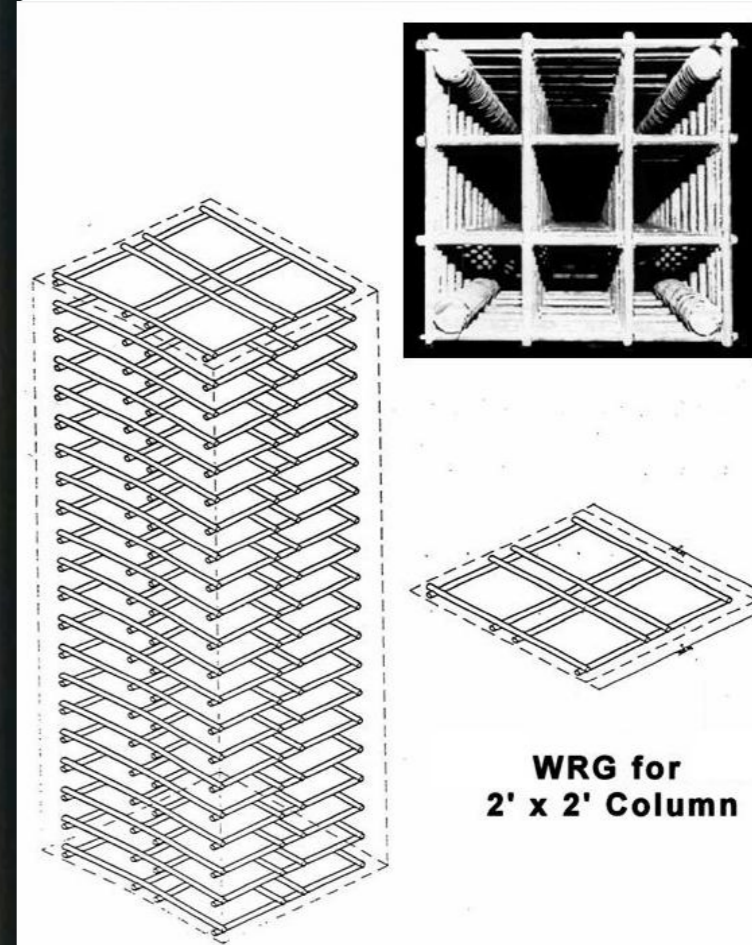
Left: Conventional confinement reinforcement with protruding hooks and $\pm 12.7\text{mm}$ dimensional tolerance

Right: Welded Reinforcement Grid (WRG) with dimensional tolerance of $\pm 3\text{mm}$ using wire with diameter of 9.5mm to 19mm



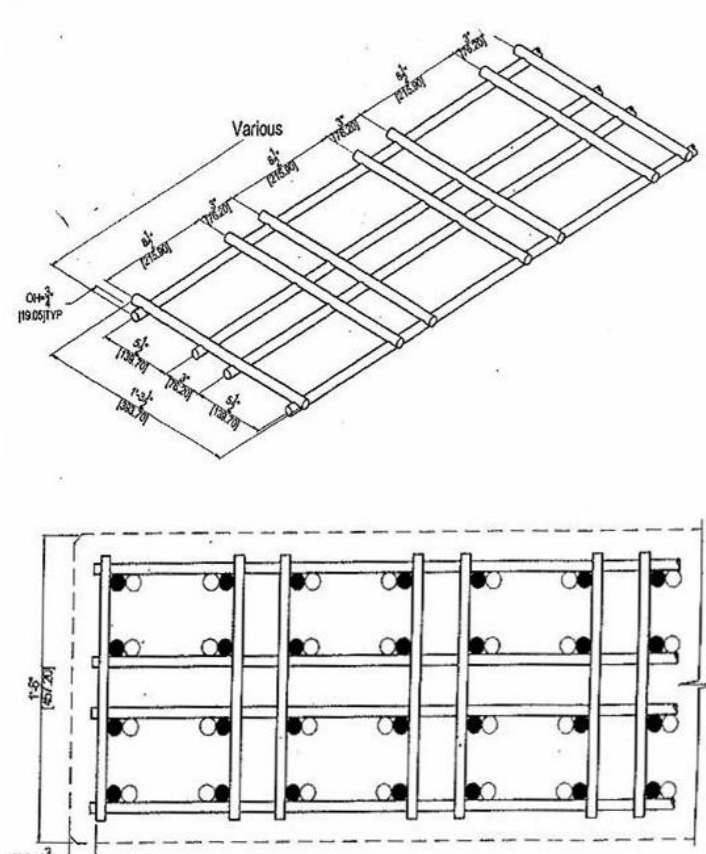
One-piece 40-cell WRG replaces 15 pieces in 5 layers of conventional hoops and cross-ties with 43% reduction in weight and no protruding hooks and only one layer of WRG

40-Cell WRG



Rebar cages with WRG are very distortion resistant because where wires cross, there is a structural weld. Tests have shown that excellent ductile performance is still possible even when 4 large rebar replace 12 smaller rebar, which reduces the number of couplers required by 67%.

WRG for 2' x 2' Column



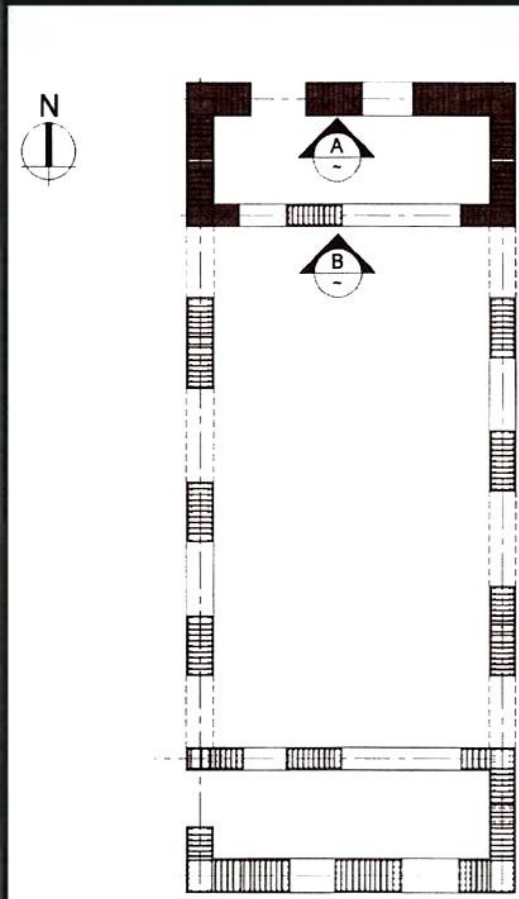
Because one-piece WRG has no laps and no protruding hooks, concrete can be placed much faster and the vibrator is not obstructed by hooks so rock process voids are reduced.



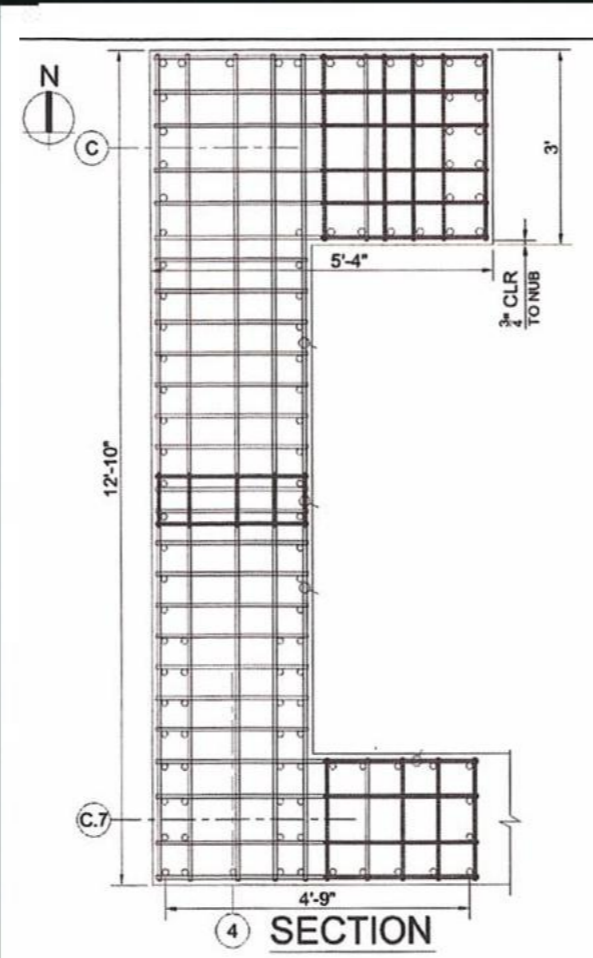
Two-story high rigid rebar cages with closely spaced WRG are quickly assembled off-site using approximately 75% less labor than conventional rebar cages having many hoops and cross-ties to wire into place. The rebar cages use rectangular, L-shaped and T-shaped WRG with WRG vertical spacing as close as 50mm.



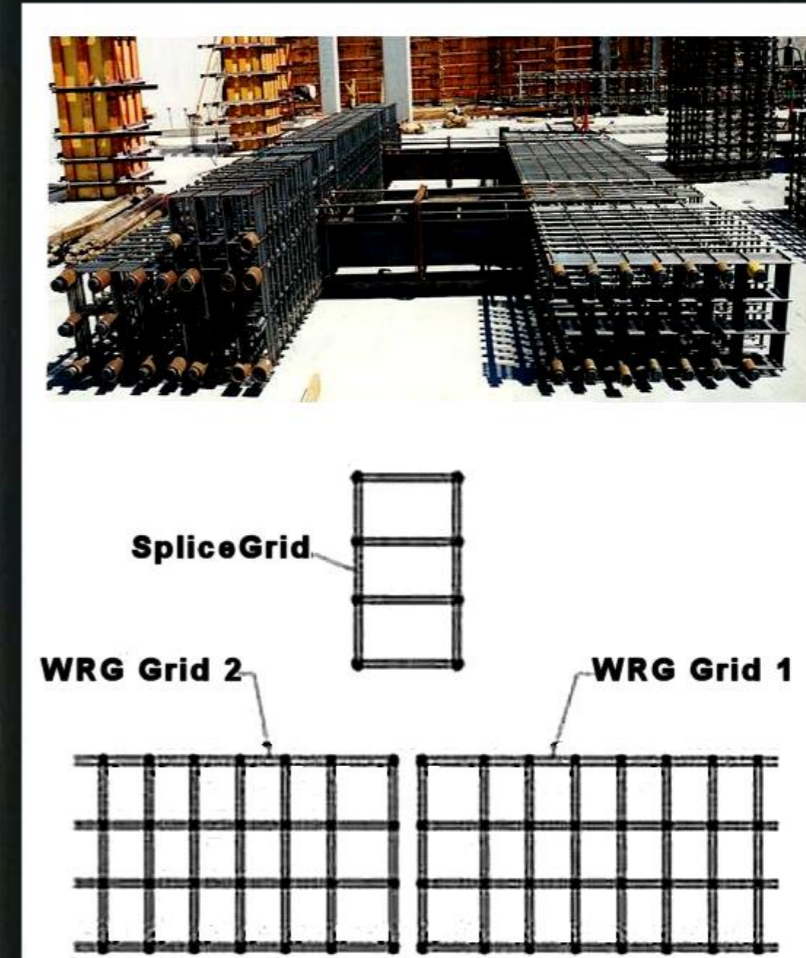
Hook-free cells of WRG allow rapid placement of concrete which has reduced construction time by more than 40% and labor by 50% when pouring concrete into rebar cages with closely spaced WRG



Concrete structures designed to resist earthquake and blast forces require closely spaced transverse confinement reinforcement to obtain inelastic deformability (Englekirk, 2003). WRG permits the rapid installation of tall reinforcement cages for these elevator cores. A rapid method of connecting the common vertical edges of the tall cages also accelerates the cage installation and core construction. The closely spaced horizontal WRG ladders with welded joints, give the tall cages large resistance to deformation, providing an ideal partner system for self-climbing forms.



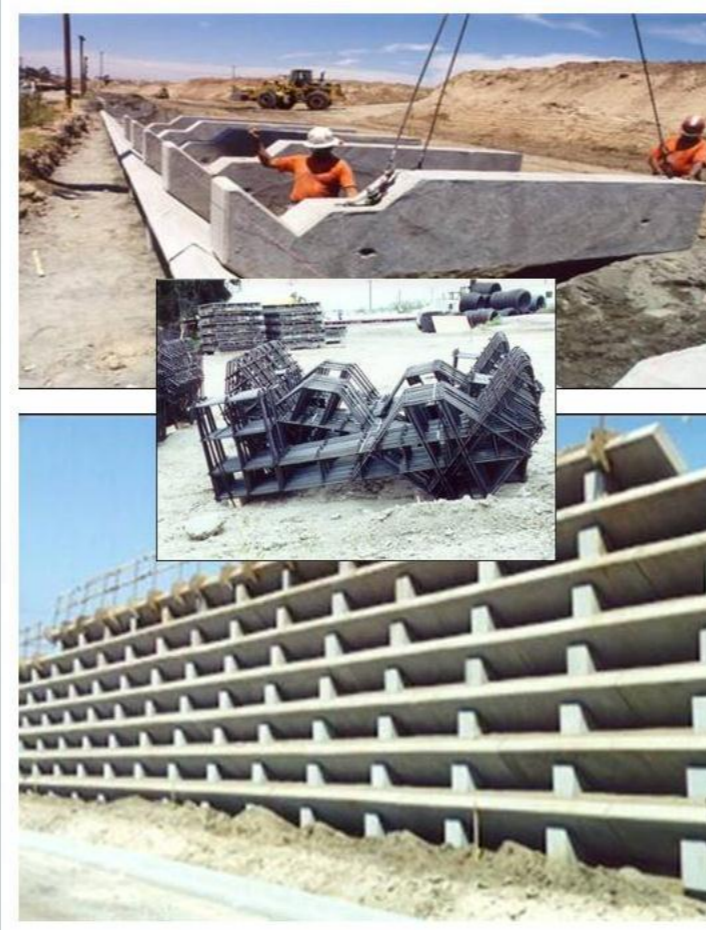
Two-story high rebar cages with WRG are very resistant to distortion so they do not corkscrew as they are being lifted into place and then connected with splice grids at the common vertical edges of the rebar cages.



At the site at ground level, coupling beams can be quickly installed into the jamb rebar cages and the entire two-story high element can be rapidly set in place and connected using splice grids at the common vertical edges.



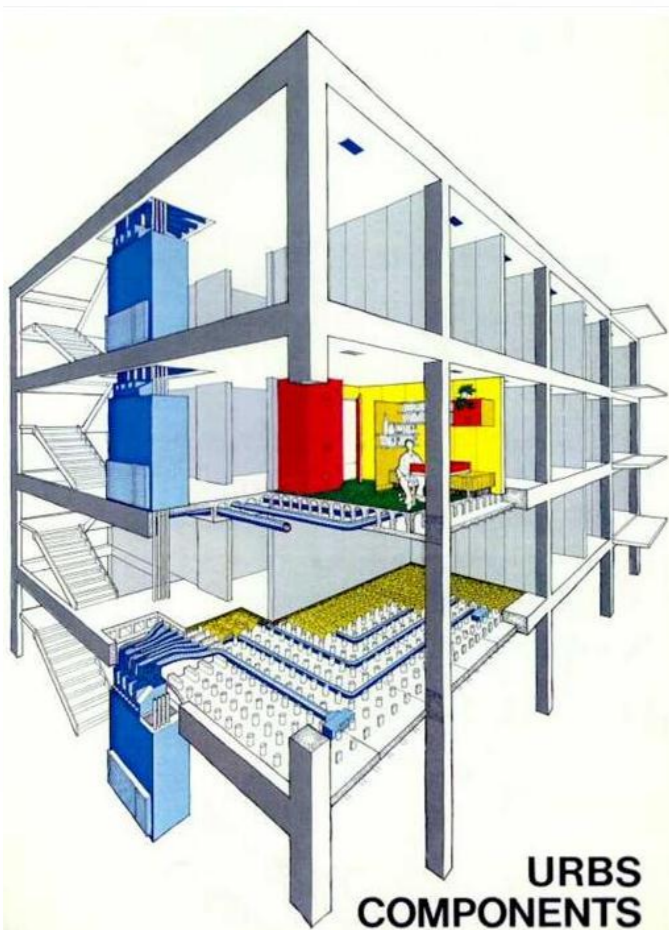
The $\pm 3\text{mm}$ dimensional accuracy of the WRG holds the vertical rebar in position so that couplers can be rapidly connected which reduces crane time and labor to install the rebar cages.



The exact dimensional tolerance of WRG allows the economical manufacturing of WRG reinforcement for odd shaped precast concrete elements for rapid construction of a landscape-faced retaining wall and precast concrete frames in the world's tallest precast concrete building in a region of highest seismicity.



A shake table test of a full-size seven-story concrete apartment module reinforced with WRG at the University of California, San Diego showed that a safe structure can be designed with 50% less vertical reinforcement than present design codes require.



Currently in development is a Hollow Concrete Floor Slab which saves energy and reduces building mass. Based upon a similar installation at the John Muir Dormitory at UCSD, the energy used to operate the HVAC system will be approximately 30% less than buildings with conventional HVAC systems.



The construction of California's tallest reinforced concrete structure, a sixty-story building in San Francisco, and the world's tallest precast building in a region of highest seismicity marks a milestone in the twenty year development of a new type of confinement reinforcement for concrete structures in seismic regions.



Recent developments in manufacturing methods and Quality Assurance processes has made it possible to produce one-piece WRG that improve ductile performance and constructability, speeds construction, and allows for cost-effective design and construction of more efficient concrete structures.