

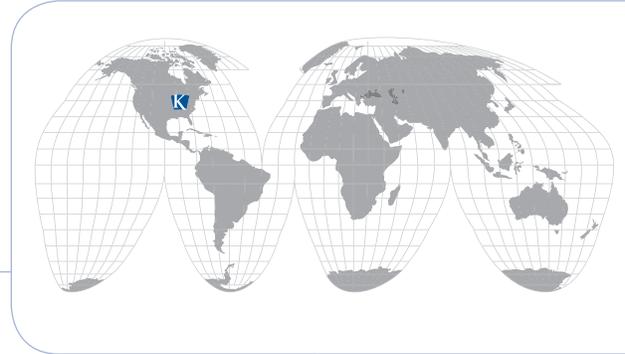


## Upper Cumberland River Flood Project Harlan, Kentucky

For years, the Cumberland River has been prone to flooding as it flows through the mountainous region of eastern Kentucky. The extremely steep terrain in the mountain valleys causes heavy rainfall to progress quickly and intensely, resulting in devastating floods. Consequently, the small town of Loyall, outside of Harlan, Kentucky, floods frequently.

The U.S. Army Corp of Engineers controls all planning, development and improvement projects along the river which affect the Cumberland River navigable waters or influence the river corridor. Due to the regular flooding and corresponding costs of cleanup and repair, the Corp of Engineers devised a plan to divert the river around Loyall. This involved a 220' (67 m) long channel that runs through the mountain corridor along with an extensive flood wall that runs parallel with Highway #417 and the four rail lines belonging to the CSX railroad. In order to encompass all of the construction between the river and the mountain, the retaining structure was necessary to support the highway and rail lines.

The Corp's first consideration for the retaining wall was a traditional concrete panel wall system. However, partway through the bidding process, Keystone Retaining Wall Systems was offered as a design alternative. The main challenge for Keystone was to meet the requirements for the Army Corp approval, through careful adherence to their regulations. Specific product data, designs, sealed engineering plans and



**Project:** Harlan, Kentucky Flood Wall and Closure, Phase III

**Location:** Harlan, Kentucky

**Owner:** US Army Corp of Engineers

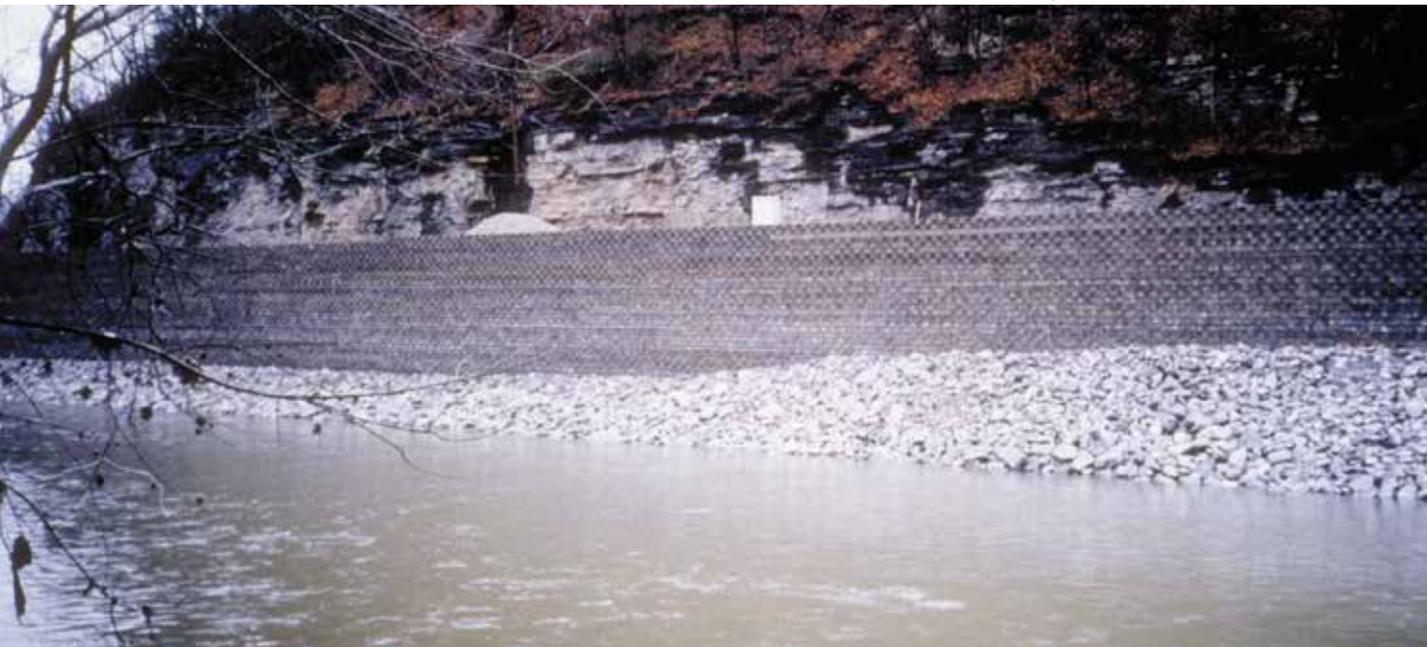
**Keystone Product:** KeySystem I, KeySteel

**Licensed Manufacturer:** Lee Brick & Block Lexington, Kentucky

**Project Size:** 27,000 square feet

**Wall Contractor:** Kay & Kay Contracting London, Kentucky

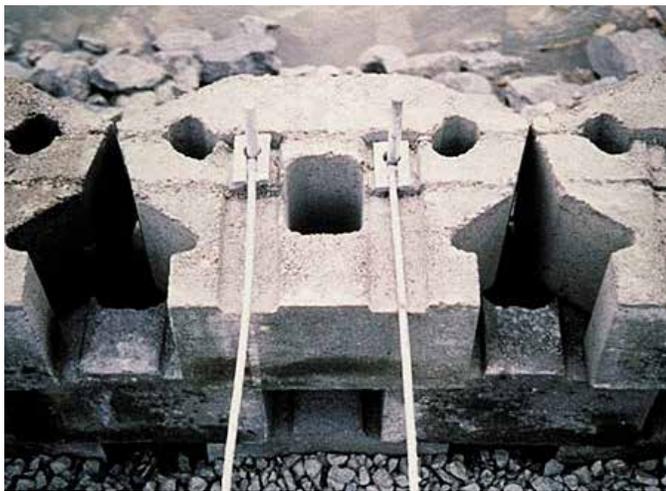
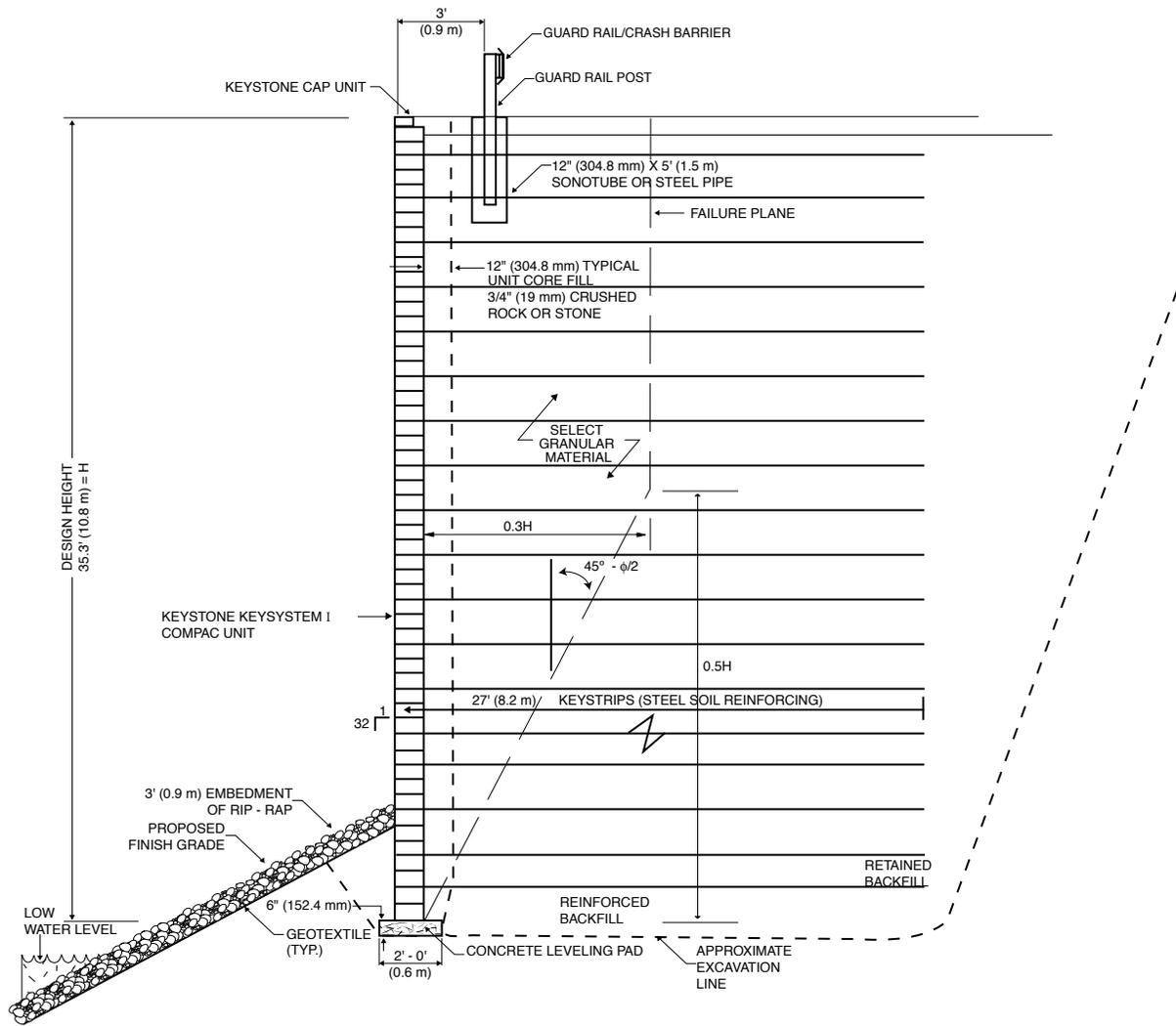
View from opposite shore of the Keystone Flood wall on the Cumberland River



CASE STUDY



# CASE STUDY



Detail of Keystone unit & KeySteel reinforcement



Detail at intersection of vertical post form & KeySteel reinforcement

other pertinent information had to be developed for inclusion in each bidder's package. Keystone's Engineering Department designed and specified the KeySystem I (concrete wall units with steel reinforcement) to fulfill the project requirements and meet the critical project deadline.

The project was awarded to Kay and Kay Contracting out of London, Kentucky, who elected to use the Keystone system due to a significant savings over alternative systems, benefits of construction

simplicity and high aesthetic results.

The project consisted of a single wall 1,250' (381 m) long, that stands 36' (11 m) tall at its highest point. Four different strengths (gauges) of steel reinforcement were used to efficiently manage the design loads developed from the wall's height and roadway surcharge. The highest strengths were in the bottom third of the wall section with the lowest strengths near the upper third where loads are reduced.



Concrete leveling pad, curved geometry & select drainable backfill.



Reinforced fill zone using "select" drainable fill

Because the base elevation of the wall started at the river's edge, construction began when the river was at its lowest point, with installation progressing at a rate to stay ahead of the spring rains. The installation method proceeded rapidly through the winter due to the granular backfill and the use of steel grid - neither of which is affected by cold weather.



Partial wall shown with forming for additional concrete leveling pad

# CASE STUDY



Partial wall shown with forming for additional concrete leveling pad

After installation of the Keystone Retaining Wall, an additional flood wall with gates was constructed at the top of the wall as a final design element to protect the town, four CSX railway tracks and the state highway from flood damage. Under the critical conditions of a future 100-year flood event, this wall will serve as a shield for the highway and the railroad by protecting against river flow rates of 122,000 cfs with velocities of 10 fps. This represents about 95% of known flood conditions. The wall design and engineering takes into account that during extreme flood conditions, the entire retaining wall will be submerged 17 feet (5.2 m) below the floods crest and yet maintain the integrity of the entire structure.

For more information on Keystone KeySystem I - KeySteel system or other innovative Keystone products, please visit [www.kestonewalls.com](http://www.kestonewalls.com) or call 800-747-8971.