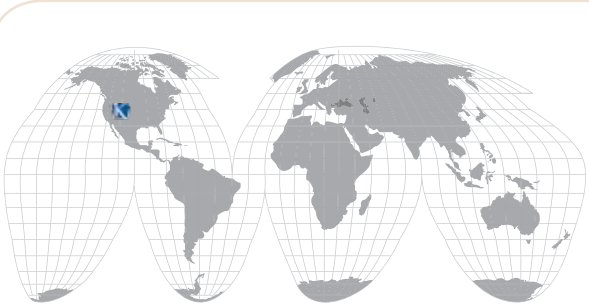
KEYSTONE® RETAINING WALL SYSTEMS
A CONTECH COMPANY



FrontRunner South Commuter Rail

Salt Lake City to Provo, UT

UTA FRONT RUNNER

A truly unique rail plan gives Utah citizens first class public transportation.

This project team helped the Utah Transit Authority (UTA) build two commuter rail lines. The FrontRunner North Commuter Rail Line runs from Salt Lake City north to Ogden. The FrontRunner South Commuter Rail Line runs from Salt Lake City south 45 miles to Provo. FrontRunner North has 5,000 square feet of retaining wall. FrontRunner South has 300,000 square feet of retaining walls. Because of the size and number of walls, our case study will focus on FrontRunner South.

Above: "Flyover" wall slip joint construction
Below: "Flyover" crosses over UPRR tracks on skew

Project:	*FrontRunner South Commuter Rail*
Location:	*Salt Lake City to Provo, UT*
Owner:	*Utah Transit Authority*
Keystone Product:	*Keystone Compac*
Licensed Manufacturer:	*Amcor Masonry Products, North Salt Lake, SLC*
Total Wall Area:	*330,000 square feet*
CM/General Contractor:	*CRC - Commuter Rail Constructors*
Wall Contractor:	*Innovative Excavation, West Jordan, SLC*
Civil Engineers:	*Parsons and HDR Engineering*
Geotechnical Engineer:	*Terracon*

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CASE STUDY

Typical Keystone railroad support walls under construction

Single-phase construction, slip joint construction, locally manufactured Keystone products, high productivity installation, wick drain installation, lightweight backfill, and low maintenance add up to a one-of-a-kind commuter ride.

If the commuters on the FrontRunner South Commuter Rail were aware of how unique and unusual the retaining and bridge abutment walls for the rail are, they might not be able to sit still long enough to enjoy the ride. A combination of engineering, design, excavation and retaining wall products make for a one of kind ride to town. Each one of these features makes FrontRunner South extraordinary.

Single-phase construction saves backhoes of dough.

The large Flyover walls over the UPRR were originally planned as a two-stage construction due to foundation settlement concerns. This means that, once excavation is done, a flexible wire mesh MSE (mechanically stabilized earth) wall is installed and allowed to settle.

Keystone wall takes over from panel wall system with a smooth transition

The second stage involves installing a permanent concrete veneer, panels, block or other product of the customer's choosing in front of the wire mesh wall. The result is that the wall is built twice. It may not cost twice as much, but the price tag is always significantly higher, plus the extra stage adds time to the overall schedule. The design and construction of the Keystone wall eliminated the two-stage process. A combination of design, engineering, lightweight backfill and Keystone modular wall units meant a single stage wall could be built, eliminating the wire mesh product and installation as well as the settlement time period. "The UTA was entertaining several two stage systems pre-bid," says John Taylor, General Manager of Innovative Companies. "If a two stage system were bid, they would have paid more money."

Slip joints help ease that sinking feeling.

Another unique feature is that slip joints were installed approximately every fifty feet in the taller sections of the Flyover walls. This permits the wall to flex in smaller sections so settlement is less of a problem. Think of your spine…flexible to bend as weather and ground shifts cause movement. A traditional wall without slip joints would behave like a fused spine with no flexibility. Adding to the engineering and construction complexity is the fact that this is a highly seismic area with poor soil conditions.

Shop locally to save freight.

The Keystone Compac Straight Face Units were manufactured and supplied by Amcor Masonry Products in North Salt Lake City which also provided the Tensar geogrid soil reinforcement required. Considering the freight costs of 300,000 square feet of block, it is clear how locally produced product was cost saving. Some of the other systems that were considered would have had to be shipped in from out of state. Such a freight bill would have been a big part of that product's final cost. Having products right down the street eliminated shipping, handling and storage concerns.

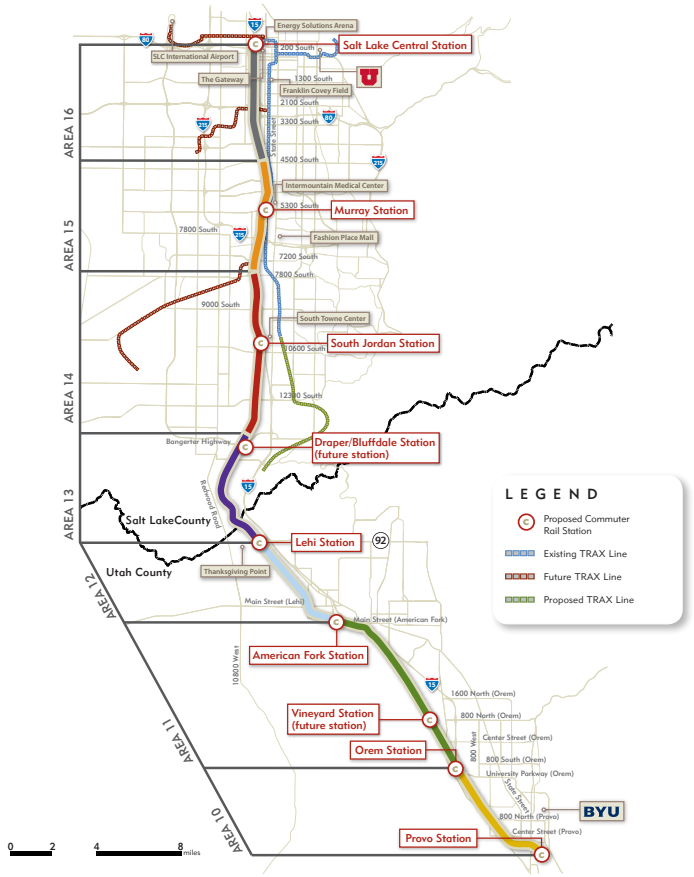
Installation speeds as fast as the rail line.

Once excavation was done, both the UTA and general contractor were amazed at how quickly the Keystone walls went up. Formal productivity measurements were not taken, but all parties familiar with other retaining wall products commented on the speed at which the Keystone walls were completed. According to John

Taylor, Innovative Companies factored this into their bid, but the productivity was better than expected.

Truly unique backfill adds stabilization without weight.
The most common backfill is dirt or granular fill because it's readily available. In this case, the engineers felt the load at the bottom of the flyover walls would be too much if standard fill options were used. After some investigating, testing and good old trial and error work, the team came up with a lava-like rock material that weighs nearly half the weight of dirt or granular fill. "We had some compaction issues with it at first, but once we figured out how to get a consistent rock size and shape, the backfill operation went very smoothly. Not only is the lava-like product easier to handle than dirt because of the weight, it delivers better load-bearing properties. It was also less expensive to acquire and to transport."
The lighter backfill material also allowed construction to continue during the winter months. Dirt holds moisture, clumps and freezes in cold weather. The lava fill did not have any of these issues. This product is ideal when you have differential settlement. Freeze-thaw conditions add to this concern, according to Taylor.

FrontRunner South: Provo to SLC



The FrontRunner Project at a Glance:

- Design build proposals were solicited by UTA from contractor led teams in 2008. Commuter Rail Constructors (Joint venture of Stacy and Witbeck, Inc. and Herzog Contracting) was awarded the project in mid 2008

- Innovative Excavation, Amcor, Keystone were awarded the contract for the retaining wall design and construction from Commuter Rail Constructors in late 2008. Design-build projects are a challenge, as the project is not designed at the time the proposals are made and the contracts awarded. All parties have to work together cooperatively to get the project designed and completed in the owner's time frame.

- There are approximately 40 retaining walls ranging in size from 5 feet to 45 feet tall that support the commuter rail system and the UPRR (Union Pacific Railroad) Flyover. Four railroad bridge abutment walls were also constructed. The walls are required to support the commuter rail system, which is less than 10 feet from the face of wall. These walls also temporarily supported UPRR railroad trains in some locations. The UPRR Flyover retaining walls reach 45 feet in height in a high seismic area. (0.40g - 0.50g)

- Most walls primarily run parallel to and support the UTA tracks that tend to run parallel to existing UPRR tracks. The new rail construction encroaches on neighboring property. Retaining walls were necessary where property or easements could not be easily obtained.

- There were a number of walls eliminated and added as the project progressed and the project requirements evolved through the design build process. There were several plan changes and design modifications made by the design-build team to accommodate site conditions.

- MSE (mechanically stabilized earth) wall systems were considered for most of the railroad support walls. Concrete walls and other gravity wall structures were generally eliminated for cost and performance reasons in these areas.

- This project is in a highly seismic area and the wall foundation soils were poor in many locations. Foundation improvements and/or lightweight backfill was required in some locations to mitigate foundation soil conditions. Special wall jointing provisions and lightweight backfill material was used in the tall UPRR Flyover walls to accommodate projected settlement.

- Innovative Companies, Amcor and Keystone were able to successfully construct, furnish, and design a complex design-build project supporting a major urban railroad system in a high seismic area and with poor foundation conditions and complex construction coordination issues.

Wicking material reduces excess water.

Large retaining walls and poor foundation soils have settlement issues. This issue was addressed by a wick drain system that was designed and installed under the walls. The excavation team drilled 80 feet into the ground at predetermined intervals and fed 6-inch diameter wicking material into the holes to accelerate clay soil drainage from the large retained fill surcharges. Wicking the water out of the ground faster and draining it away helped accelerate settlement and reduces the long term settlement duration.

Abutment construction in between interstate bridges

Completed Abutment

Completed Abutment with beams being set

Other considerations

Because the commuter rail line runs over the Union Pacific Railroad track, during construction, workers had to comply with the Railroad's rules and regulations in addition to the UTA's rules. This involved some safety, noise, and work hour regulations. "It's all for the protection of the workers, the neighborhood and the environment, which is good, but it did add some extra 'dance steps,'" according to Paul Rueckert of Amcor Masonry.

The commuter line had to go over the railroad tracks because of property restraints. The Flyover wall structure is extremely unique. It's a 45 foot high, 48 foot across, by 3,000 linear feet of approach walls for the UPRR crossing.

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