

# GENERAL KEYSTONE INSTALLATION PROCEDURE

## STEP 1: PREPARE SITE

REMOVE ALL SURFACE VEGETATION, DEBRIS, AND ORGANIC MATERIAL. THIS MATERIAL SHOULD NOT BE USED AS STRUCTURAL BACKFILL. AS REQUIRED, EXCAVATE SITE SOILS TO ALLOW FOR PLACEMENT OF THE KEYSTONE UNITS AND SOIL REINFORCEMENT. IF A WALL IS BEING BUILT ON FILL, THIS STEP MAY NOT BE NECESSARY.

## STEP 2: INSTALL ARCH CULVERT PER SITE PLANS AND CONTECH PLATE ASSEMBLY INSTRUCTIONS

## STEP 3: EXCAVATE BASE TRENCH/DESIGN AND CONSTRUCTION PROCEDURES

AFTER SELECTING THE LOCATION AND LENGTH OF THE WALL, EXCAVATE THE BASE LEVELING PAD TRENCH. THE TOP OF LEVELING PAD MUST BE A MINIMUM OF 24" (610 mm) BELOW FINISHED GRADE. SCOUR MAY REQUIRE THE WALL EXTEND MORE DEEPLY OR THAT SCOUR PROTECTION BE USED. THE BASE TRENCH SHOULD BE WIDE ENOUGH TO ALLOW FOR THE KEYSTONE UNIT AND UNIT DRAINAGE FILL ZONE. THE BASE TRENCH SHOULD BE A MINIMUM OF 36" (900 mm) WIDE FOR STANDARD UNITS. THE BASE TRENCH MUST BE DUG DEEP ENOUGH TO ALLOW FOR PLACEMENT OF THE BASE LEVELING PAD AND THE BURIED KEYSTONE UNITS. LEVEL AND COMPACT SOILS IN THE BASE TRENCH PRIOR TO INSTALLATION OF THE LEVELING PAD.  
NOTE: THE NUMBER OF BURIED COURSES IS TYPICALLY THREE UNITS FOR THESE APPLICATIONS UNLESS OTHERWISE SPECIFIED BY THE ENGINEER. THE COMBINED DEPTHS OF THE BASE LEVELING PAD AND BURIED UNITS IS THE TOTAL DEPTH OF THE BASE TRENCH.  
THERE ARE THREE EXCEPTIONS TO THIS RULE FOR DETERMINING THE PROPER DEPTH OF THE BASE TRENCH AND UNIT DRAINAGE FILL:  
1. POOR SOIL CONDITIONS MAY REQUIRE A MUCH LARGER DEPTH OF BASE LEVELING PAD MATERIAL OR SOIL REINFORCEMENT. THIS EXTRA MATERIAL WOULD BE USED TO IMPROVE THE BEARING CAPACITY OF THE SUBGRADE TO FULLY SUPPORT THE WEIGHT OF THE RETAINING WALL.  
A GEOTECHNICAL ENGINEER SHOULD EVALUATE SUCH CONCERNS.

- CONSTRUCTION OF A WALL ON A STEEP SLOPE. WHEN USING THE STANDARD BASE TRENCH GUIDELINES, THE AMOUNT OF PASSIVE SOIL IN FRONT OF A WALL CONSTRUCTED ON A SLOPE IS REDUCED SIGNIFICANTLY. THIS REQUIRES AN INCREASE IN THE BASE TRENCH TO MEET MINIMUM REQUIREMENTS, AS DETERMINED BY THE ENGINEER.
- STEPPING UNITS UP ALONG A SLOPING GRADE. WHEN THE GRADE RUNNING PARALLEL WITH THE WALL IS NOT LEVEL WITH THE TOP OR BOTTOM OF THE KEYSTONE UNITS, THE DEPTH OF THE BASE TRENCH AND DEPTH OF THE UNITS BELOW GRADE WILL VARY. MAINTAIN THE MINIMUM DEPTH OF BURIED KEYSTONE UNITS.

## STEP 4: CONSTRUCT BASE LEVELING PAD

BEGIN FIRST BY SELECTING THE PROPER BASE LEVELING PAD MATERIAL. A REINFORCED CONCRETE PAD IS TYPICALLY UTILIZED WHERE SCOUR POTENTIAL EXISTS, OTHERWISE A 6" MIN. DEPTH CRUSHED STONE BASE IS USED, (IE. CLASS #6, BURMA, ROAD BASE). THE MAXIMUM PARTICLE SIZE IS 1" (25 mm). THE MINIMUM PARTICLE SIZE IS NO MORE THAN 15% OF THE VOLUME PASSING A NO. 200 SEIVE. LARGER MATERIAL WILL MAKE LEVELING MORE DIFFICULT. THE FOLLOWING ARE OPTIONS:  
OPTIONS:  
1. 3/8" TO 3/4" (10 - 20 mm) CLEAN CRUSHED STONE IN AREAS WITH HIGHER MOISTURE LEVELS.  
2. A 2000± PSI (14 mPa) NON-REINFORCED CONCRETE LEVELING PAD (6" THICK).  
3. A 3500 PSI (21 mPa) REINFORCED CONCRETE FOOTING. THIS OPTION IS USED ONLY IN CRITICAL APPLICATIONS AS RECOMMENDED BY THE ENGINEER.  
NOTE: DO NOT USE PEA ROCK OR ROUNDED AGGREGATE FOR THE BASE LEVELING PAD.

PLACE CRUSHED STONE BASE LEVELING PAD MATERIAL AND COMPACT WITH APPROPRIATE EQUIPMENT TO ACHIEVE PROPER DENSITY. COMPACT BASE MATERIALS TO STANDARD PROCTOR OR 90% MODIFIED PROCTOR (SOIL TESTING STANDARDS) TO DETERMINE % OF MAXIMUM SOIL DENSITY. CRUSHED STONE SHOULD BE COMPACTED TO YIELD (IF PROCTOR TESTING CAN NOT BE PERFORMED ON CRUSHED STONE MATERIALS). REQUIREMENTS FOR THE TYPE OF TESTING PROGRAM, LOCATIONS AND FREQUENCY IS THE RESPONSIBILITY OF THE ENGINEER OF RECORD OR OWNER. COMPACT THE BASE LEVELING PAD TO A LEVEL CONDITION. CHECK FOR ACCURACY USING A LEVEL/TRANSIT OR HAND LEVEL. USE SAND OR FINE GRANULAR MATERIAL FOR MINOR ADJUSTMENTS. WHEN CONCRETE (NON-REINFORCED) LEVELING PAD IS BEING USED, SET BATTER BOARD, POUR CONCRETE AND SCREED LEVEL.

WHEN BUILDING ON A LEVEL GRADE CONDITION, THE BASE LEVELING PAD IS PLACED FOR THE FULL LENGTH OF THE WALL BEFORE KEYSTONE UNITS ARE INSTALLED. WALLS BUILT ON A SLOPING LATERAL GRADE MAY REQUIRE A STEPPED BASE. IN THESE CONDITIONS, THE BASE LEVELING PAD AND THE FIRST COURSE OF KEYSTONE UNITS ARE INSTALLED FOR EACH LENGTH OF A STEP IN GRADE. BEGINNING AT THE LOWEST ELEVATION, PLACE AND COMPACT THE BASE LEVELING PAD MATERIAL. NEXT, INSTALL THE FIRST COURSE OF KEYSTONE UNITS. AFTER LEVELING AND ALIGNMENT OF THESE UNITS IS COMPLETE, PLACE AND COMPACT THE BASE LEVELING PAD FOR THE NEXT STEP IN GRADE. WHILE DOING SO, PLACE THE SAME MATERIAL AROUND THE UNITS CLOSEST TO THE STEP IN GRADE TO STABILIZE THEIR POSITION. THE TOP OF THE LAST KEYSTONE UNIT BECOMES THE GRADE LEVEL FOR THE TOP OF THE BASE LEVELING PAD. THIS UNIT RETAINS THE BASE LEVELING PAD MATERIAL FOR THE NEXT STEP IN GRADE.

## STEP 5: SET AND ALIGN THE BASE COURSE

BEGIN AT THE LOWEST WALL ELEVATION. PLACE ALL UNITS PARALLEL TO THE ALIGNMENT LINE. THE MACHINED EDGES OF ADJOINING UNITS SHOULD CONTACT EACH OTHER. THIS PROCEDURE APPLIES TO STRAIGHT WALLS (SEE CONSTRUCTION MANUAL ON "CURVES" FOR RELATED INFORMATION). BE SURE ALL UNITS ARE SET TO SIDE UP. THE TOP SIDE HAS 4 PIN HOLES CENTERED BETWEEN TWO KIDNEY RECEIVING HOLES. ALL UNITS SHOULD REST FIRMLY ON THE BASE LEVELING PAD. IF ANY ROCKING MOTION OCCURS, ADJUST BASE LEVELING PAD MATERIAL OR UNITS TO ACHIEVE SOLID CONTACT WITH THIS SURFACE.  
CHECK AND ADJUST THE LEVEL AND ALIGNMENT OF ALL UNITS. THE POSITION OF THE BASE COURSE DETERMINES THE ALIGNMENT OF ALL SUCCEEDING COURSES. ADJUSTMENTS TO ALIGNMENT MUST BE MADE AT THIS TIME. DO NOT ALIGN THE UNITS USING THE SPLIT FACE SURFACE. INSTEAD, VERIFY THE PROPER POSITION OF ALL KEYSTONE UNITS BY EXAMINING A STRAIGHT LINE ACROSS THE BACK OF THE UNITS OR OVER THE TOP OF THE UNIT HOLES.

LEVEL KEYSTONE UNITS SIDE TO SIDE USING A 48" (1.2 m) OR LONGER LEVEL. UNITS CAN BE LEVELED FRONT TO BACK USING A MINIMUM 24" (610 mm) LEVEL. IF A LEVEL/TRANSIT IS USED, SPOT CHECK EVERY 4th OR 5th UNIT. THE TOP SURFACE OF TWO ADJOINING UNITS SHOULD ALIGN (+) 1/8" (3 mm). MINOR HEIGHT ADJUSTMENTS CAN BE MADE BY TAPING THE UNIT WITH A RUBBER Mallet OR BY PLACING SMALL AMOUNTS OF COURSE SAND UNDER THE UNITS. APPLYING EXCESSIVE VERTICAL FORCE IN AN ATTEMPT TO ADJUST THE HEIGHT ALIGNMENT COULD PRODUCE STRESS FRACTURES. PLACEMENT OF MORE THAN 3/4" (20 mm) OF LOOSE MATERIAL COULD LEAD TO UNACCEPTABLE MOVEMENT.  
ALL BASE COURSE UNITS CAN BE PLACED FOR AN ENTIRE WALL LENGTH OR FOR A SMALL SEGMENT OF THE FULL LENGTH. TO REDUCE THE MOVEMENT OF BASE UNITS FROM CONSTRUCTION EQUIPMENT, PLACE UNIT DRAINAGE FILL MATERIAL AFTER PLACEMENT AND LEVELING OF EACH TEN UNITS. WHEN PLACING THE BASE COURSE FOR A WALL WITH A STEPPING GRADE, SET ALL UNITS AT THE LOWEST GRADE ELEVATION FIRST. SECURE THE POSITION OF THESE UNITS (AS DESCRIBED IN THE "PREPARATION, EXCAVATION, BLOCK EMBEDMENT NOTES"). PLACEMENT OF THE BASE COURSE FOR THE NEXT STEP IN GRADE SHOULD BEGIN BY PLACING A MINIMUM OF 1-1/2' OVERLAPPING UNITS. THIS WILL ENSURE PROPER INTERLOCK POSITION FOR ADDITIONAL UNITS.

## STEP 6: INSERT FIBERGLASS CONNECTING PINS

BEFORE INSTALLING THE PINS SELECT A BATTER OPTION. "BATTER" IS THE SLOPE OF THE FACE OF THE WALL UPWARD AND BACKWARD SO THAT THE WALL LEANS INTO THE EMBANKMENT BEING RETAINED. BATTER IS MECHANICALLY CONTROLLED BY THE PIN POSITION. UNITS WITH FOUR PIN HOLES APPEARING IN THE TOP OF THE KEYSTONE UNIT HAVE THREE BATTER OPTIONS: 8.8" (1-1/4" (30 mm)), 4.4" (5/8" (15 mm)), OR NEAR VERTICAL.  
A 8.8" OR 4.4" BATTER MAY BE USED FOR SOME INSTALLATIONS. STRAIGHT WALLS ARE WELL SUITED FOR THIS BATTER OPTION. A NEAR VERTICAL BATTER WORKS WELL FOR TALL GEOGRID REINFORCED WALLS WITH TIGHT RADIUS CURVES, CORNERS AND WORKING AROUND CULVERTS AND HEADWALLS.  
PLACE TWO KEYSTONE PINS INTO TWO OF THE PREFORMED HOLES IN THE TOP OF EACH KEYSTONE UNIT. IN SOME CASES A LIGHT SLAG FILM MAY COVER PART OR ALL OF THE HOLE. IN THESE CONDITIONS, USE A HAMMER TO TAP THE PIN THROUGH THE CONCRETE SLAG AND INTO THE OPENING. ONCE IN POSITION, A MINIMUM 1-1/4" (30 mm) SEGMENT OF THE PIN SHOULD PROTRUDE OUT OF THE OPENING ABOVE THE TOP SURFACE OF THE UNIT.

## STEP 7: PLACE UNIT/DRAINAGE MATERIAL

FILL THE KEYSTONE UNIT VOIDS AND DRAINAGE ZONE WITH 3/8" (10 mm) TO 3/4" (20 mm) UNIT DRAINAGE FILL MATERIAL. THE UNITS VOIDS ARE THE OPENINGS AND SPACES BETWEEN UNITS. THE DRAINAGE ZONE IS THE COMBINED AREA OF THE UNIT VOIDS AND/OR ADDITIONAL AREA BEHIND THE UNIT. THE WIDTH OF UNIT/DRAINAGE MATERIAL SHOULD BE A MINIMUM OF 24" (610 mm), MEASURED FROM THE WALL FACE. CERTAIN SITE CONDITIONS MAY REQUIRE A GREATER WIDTH OF THIS MATERIAL. PLACE MATERIAL INTO THE SPECIFIED AREA. A CLEAN CRUSHED STONE MATERIAL WILL CONSOLIDATE NATURALLY. DO NOT OPERATE ANY AUTOMATED COMPACTION EQUIPMENT DIRECTLY OVER THE KEYSTONE UNITS IN AN ATTEMPT TO COMPACT THIS MATERIAL. THIS MAY RESULT IN DAMAGE TO THE UNITS.  
PROPER PLACEMENT OF THE UNIT/DRAINAGE MATERIAL SERVES THREE IMPORTANT PURPOSES. FIRST, PLACING THIS MATERIAL BETWEEN UNITS ON ADJOINING COURSES CREATES A POSITIVE INTERLOCK BETWEEN UNITS. IF GEOGRID REINFORCEMENT IS USED, FRICTION INTERLOCK WITH THE WALL FACE IS SIGNIFICANTLY IMPROVED. IN ADDITION, THIS MATERIAL WILL INCREASE THE OVERALL WEIGHT OF EACH KEYSTONE UNIT: A VERY IMPORTANT FEATURE. FINALLY, IT WILL PERMIT THE RELEASE OF HYDROSTATIC PRESSURES WHICH MAY BUILD UP BEHIND THE WALL FACE. INSTALL GEOTEXTILE FABRIC BETWEEN UNIT DRAINAGE FILL AND WALL BACKFILL AS REQUIRED IN WATER CONDITIONS.

## STEP 8: GEOGRID INSTALLATION

THE BASIC INSTALLATION TECHNIQUES FOR USE OF A TENSAR GEOGRID WITH A KEYSTONE RETAINING WALL ARE OUTLINED IN THE FOLLOWING STEPS. CONSULT THE GEOGRID MANUFACTURER FOR ADDITIONAL INSTALLATION DETAILS.

- FOLLOW THE INSTRUCTIONS IN THE PREVIOUS INSTALLATION NOTES UNTIL YOU HAVE REACHED THE LOWEST WALL ELEVATION WHERE A GEOGRID LAYER WILL BE PLACED. THIS ELEVATION, ALONG WITH THE ELEVATION OF ANY ADDITIONAL GEOGRID LAYERS, WILL BE SPECIFIED IN THE ENGINEERING DESIGN FOR THE WALL. AT THIS POINT, THE BASE TRENCH WILL HAVE BEEN EXCAVATED, THE BASE LEVELING PAD WILL HAVE BEEN PLACED, THE INITIAL COURSES OF KEYSTONE UNITS WILL HAVE BEEN INSTALLED AND THE UNIT DRAINAGE FILL AND RETAINED BACKFILL WILL HAVE BEEN PLACED AND COMPACTED UP TO THE FIRST ELEVATION WHERE A GEOGRID LAYER IS SPECIFIED.
- MEASURE AND CUT THE GEOGRID MATERIAL TO THE SPECIFIED LENGTH. REFER TO SITE SPECIFIC ENGINEERING DOCUMENTS FOR LENGTH OF GEOGRID LAYERS AND TYPE OF GEOGRID MATERIAL. FOR INFORMATION ON PROPER PLACEMENT OF GEOGRID ALONG CURVES OR CORNERS, CONSULT THE GEOGRID MANUFACTURER'S RECOMMENDATIONS. SOME WALL DESIGNS MAY REQUIRE MORE THAN ONE STRENGTH OF GEOGRID AND MORE THAN ONE LENGTH FOR THE GEOGRID LAYERS. IT IS CRITICAL TO CONFIRM THIS INFORMATION BEFORE PROCEEDING. IF MULTIPLE TYPES AND/OR LENGTHS OF GEOGRID WILL BE USED, PRECUTTING AND MARKING EACH GEOGRID PIECE (FOR EXAMPLE WITH COLORED SPRAY PAINT) WILL MAKE IDENTIFICATION EASIER AND REDUCE THE CHANCE OF MISPLACEMENT. IN ADDITION, VERIFY THE PROPER ORIENTATION OF THE GEOGRID TO THE WALL FACE. MOST GEOGRIDS HAVE A DESIGN STRENGTH ALONG ONE DIRECTION OF THE MATERIAL. THESE ARE CALLED UNIAXIAL GEOGRIDS. THE DIRECTION OF DESIGN STRENGTH OF A UNIAXIAL GEOGRID IS TYPICALLY PARALLEL TO THE DIRECTION OF THE ROLL OF GEOGRID. GEOGRID CAN EITHER BE FIELD CUT OR PRECUT USING A VARIETY OF TOOLS. THE TYPE OF GEOGRID BEING USED WILL DETERMINE CUTTING PROCEDURES. FOR LARGE INSTALLATIONS, THE GEOGRID IS MOST EFFICIENTLY CUT OFF SITE IN A CONTROLLED SETTING. IN ALL CASES, CUT THE GEOGRID IN SUCH A WAY SO THAT THE END OF THE LAYER THAT IS NEAREST THE FRONT OF THE WALL IS TRIMMED CLOSE TO THE TRANSVERSE BAR. THIS WILL PREVENT UNSIGHTLY PIECES OF GEOGRID FROM PROTRUDING OUT OF THE WALL FACE.
- KEYSTONE PINS SHOULD BE PLACED INTO ALL UNITS. HOOK THE GEOGRID OVER THE KEYSTONE PINS. LAY THE GEOGRID OUT FLAT ON COMPACTED BACKFILL. FOLLOW THE ENGINEERING DESIGN FOR GEOGRID PLACEMENT. IT WILL SPECIFY BOTH THE HORIZONTAL AND VERTICAL START /STOP LOCATIONS. IN GENERAL, GEOGRID WILL BE PLACED IN PIECES SIDE BY SIDE IN A CONTINUOUS LAYER ALONG THE LENGTH OF THE WALL UNLESS A CHANGE IN ELEVATION IS SPECIFIED IN THE DESIGN. CHECK ENGINEERING DOCUMENTATION FOR DETAILS.
- TENSION THE GEOGRID BY PULLING IT TOWARDS THE EMBANKMENT. PLACE A STAKE THROUGH THE GEOGRID AND INTO THE GROUND. WHILE USING THE STAKE AS A LEVER AND TENSIONING THE GEOGRID, DRIVE THE STAKE INTO THE GROUND TO HOLD THE POSITION. DO NOT EXCESSIVELY TENSION GEOGRID. THIS MAY PULL UNITS OUT OF THEIR PROPER ALIGNMENT. INSTALL AN ADDITIONAL COURSE OF KEYSTONE UNITS OVER THE GEOGRID, AND PLACE PINS IN THIS COURSE.
- PROCEED WITH PLACEMENT OF THE UNIT FILL/DRAINAGE ZONE CRUSHED STONE MATERIAL AND THE BACKFILL IN THE REINFORCED ZONE. SPECIFICATIONS FOR MATERIAL USED IN THE REINFORCED ZONE ARE DEFINED. BEGIN PLACEMENT OF THIS MATERIAL NEAR THE KEYSTONE UNITS, MOVING PROGRESSIVELY TOWARD THE CUT EMBANKMENT. THIS PROCEDURE WILL KEEP THE GEOGRID UNDER TENSION. AFTER COMPLETING THIS BACKFILL PROCESS, THE TENSION STAKES MAY BE REMOVED FOR REUSE. COMPACT THE BACKFILL MATERIAL TO 95% STANDARD PROCTOR. CONTINUE WITH CONSTRUCTION ACCORDING TO THE PREVIOUS INSTALLATION NOTES UNTIL REACHING THE NEXT WALL ELEVATION WHERE A GEOGRID LAYER IS TO BE PLACED. REPEAT STEPS 3-6.

THE CHARTS REQUIRE THE USE OF TENSAR GEOGRID:  
UX1400SB OR UX1500SB BY TENSAR CORPORATION

ALL GEOGRID LENGTHS SHOWN ARE THE ACTUAL LENGTHS OF GEOGRID REQUIRED AS MEASURED FROM THE CONNECTION PINS TO THE END OF THE GEOGRID.

THE DESIGN CHARTS ASSUME THAT THE WALLS ARE CONSTRUCTED IN ACCORDANCE WITH KEYSTONE SPECIFICATIONS AND GOOD CONSTRUCTION PRACTICE. ALL SOILS MUST BE COMPACTED IN 8" (200 mm) LIFTS TO 95% STANDARD PROCTOR DENSITY AS DETERMINED BY LABORATORY TESTING. THE INFORMATION CONTAINED IN THE DESIGN CHARTS IS FOR PRELIMINARY DESIGN USE ONLY. A QUALIFIED PROFESSIONAL SHOULD BE CONSULTED FOR FINAL DESIGN ASSISTANCE. KEYSTONE ACCEPTS NO LIABILITY FOR THE IMPROPER USE OF THESE CHARTS.

## STEP 9: BACKFILL AND COMPACT SOILS

THE DEPTH OF THIS AREA WILL VARY DEPENDING ON THE SITE CONDITIONS AND CONSTRUCTION PROCEDURES USED. WALLS CONSTRUCTED IN A FILL CONDITION WILL REQUIRE THE PLACEMENT OF LARGE VOLUMES OF THIS MATERIAL. WALLS BUILT INTO CUT CONDITIONS WILL REQUIRE VARYING QUANTITIES OF MATERIAL DEPENDING ON THE AMOUNT OF OVER EXCAVATION.  
THE SAME PLACEMENT RULES APPLY FOR EACH CONDITION. IN GENERAL, ALL SOILS SHOULD BE PLACED IN NO MORE THAN 8" (200 mm) THICK LIFTS, THE HEIGHT OF A SINGLE KEYSTONE UNIT. MORE SPECIFICALLY, THE PROPER THICKNESS OF MATERIAL PLACED IN A SINGLE LIFT IS DEPENDENT ON THE TYPE OF SOILS AND COMPACTION EQUIPMENT BEING USED. FOR EXAMPLE, CRUSHED STONE (USED FOR UNIT/DRAINAGE) MAY BE PLACED IN MAXIMUM LIFTS AND WILL COMPACT WITH MINIMAL EFFORT. MOST INORGANIC SITE SOILS, EASILY INFLUENCED BY MOISTURE LEVELS, MUST BE PLACED IN SHORTER LIFTS AND WILL REQUIRE GREATER COMPACTION EFFORT.

FOR COMPACTION, THE BACKFILL SOILS NEED TO BE COMPACTED TO A MINIMUM 95% STANDARD PROCTOR (95% OF THE SOILS MAXIMUM DENSITY). BOTH THE TYPE OF MATERIAL AND THE COMPACTION EQUIPMENT NEED TO BE CONSIDERED WHEN ADDRESSING THIS ISSUE. SOILS COMPACTED WITH WALK BEHIND EQUIPMENT WILL REQUIRE THE PLACEMENT OF THIN LAYERS OF MATERIAL. USING RIDE-ON MECHANICAL EQUIPMENT WILL ALLOW PLACEMENT OF THICKER LIFTS OF MATERIAL. CONSULT AN ENGINEER FOR SPECIFIC RECOMMENDATIONS. THE FOLLOWING ARE BASIC GUIDELINES:

- BACKFILL MATERIAL MUST HAVE THE PROPER MOISTURE CONTENT FOR OPTIMUM PERFORMANCE WHEN COMPACTING.
- ORGANIC OR HEAVY CLAY MATERIAL SHALL NOT BE USED. THESE MATERIALS HOLD MOISTURE AND DO NOT COMPACT PROPERLY.
- WALK BEHIND MECHANICAL COMPACTION EQUIPMENT MAY BE USED TO COMPACT ANY SOILS PLACED BEYOND THE UNIT/DRAINAGE ZONE.
- RIDE-ON MECHANICAL COMPACTION EQUIPMENT SHOULD BE OPERATED NO CLOSER THAN WITHIN 3' (1 m) OF THE KEYSTONE UNIT BACK SURFACE.
- DO NOT OVER COMPACT OR COMPACT SOILS NEXT TO THE BACK OF THE UNIT IN AN UNCONTROLLED MANNER. THIS MAY DRIVE DRAINAGE MATERIAL UNDER THE UNIT, FORCING THE UNITS OUT OF LEVEL. IF THIS CONTINUES, THE WALL MAY BEGIN TO LEAN FORWARD.
- ALL SOIL TESTING SHOULD BE PERFORMED BY A QUALIFIED ENGINEER. SOIL TEST SHOULD BE TAKEN NO CLOSER THAN 3' FROM THE BACK SURFACE OF THE KEYSTONE UNIT.
- BACKFILL MATERIAL IN THE PIPE ZONE MUST BE AS SHOWN ON THE SITE SPECIFIC PLANS AND SPECIFICATIONS
- GEOTEXTILE SEPARATORS BETWEEN UNIT FILL AND BACKFILL MUST BE PLACED WHILE BACKFILLING

WHILE PLACING BACKFILL MATERIAL BEHIND THE FIRST COURSE OF KEYSTONE UNITS, REPLACE THE PASSIVE SOIL WEDGE AT THE FRONT OF THE UNITS. THIS WILL SECURE THE PROPER ALIGNMENT OF ALL UNITS.

## STEP 10: SWEEP TOP OF UNITS CLEAN

REMOVE ALL EXCESS UNIT/DRAINAGE MATERIAL FROM THE TOP SURFACE OF ALL UNITS. THIS ALLOWS A SMOOTH SURFACE FOR PLACEMENT OF THE NEXT COURSE OF KEYSTONE UNITS. IF SMALL STONES BECOME SANDWICHED BETWEEN UNITS, POINT LOADING MAY OCCUR RESULTING IN STRESS FRACTURES. THIS MATERIAL MAY ALSO LEAVE UNITS OUT OF LEVEL, CREATING VISUAL DISTORTION. IF DUE TO THE MANUFACTURING PROCESS, RIDGES OR SLAG MATERIAL ARE PRESENT, REMOVE BY USING A TOOL OR USE THE NEXT COURSE UNIT BEING PLACED TO RUB THE HIGH SPOT OFF.

## STEP 11: INSTALL ADDITIONAL COURSES OF KEYSTONE UNITS

PLACE ADDITIONAL COURSES OF KEYSTONE UNITS. EACH UNIT WILL BE PLACED OVER TWO UNITS BELOW CREATING A RUNNING BOND FACE PATTERN. EASIEST PLACEMENT OF THE KEYSTONE UNITS IS ACCOMPLISHED IN THE FOLLOWING STEPS:

- LIFT EACH KEYSTONE UNIT BY ITS BACK TAIL SECTION TO MOVE IT INTO POSITION.
- CENTER THE UNIT IN FRONT OF THE POINT WHERE THE TWO UNITS BELOW MEET.
- SET THE FACE OF THE UNIT ONTO THE FRONT EDGE OF THE TWO UNITS BELOW.
- WITH THE KEYSTONE UNIT IN THIS POSITION, SLOWLY LOWER IT TO CONTACT THE TWO UNITS BELOW. WHILE LOWERING THE UNIT, THE TWO KIDNEY RECEIVING HOLES SHOULD SLIP OVER ONE FIBERGLASS PIN IN THE UNITS BELOW (OPEN KIDNEY WILL ALLOW A VISUAL CHECK).
- PULL THE UNIT FORWARD TO ENGAGE PINS. THE UNIT WILL BE LOCKED INTO A BATTER POSITION. VISUALLY CHECK TO SEE THAT THE UNIT IS PARALLEL TO THE UNITS BELOW. AFTER SETTING A LENGTH OF KEYSTONE UNITS, VISUALLY CHECK THE OVERALL ALIGNMENT. MAKE MINOR ADJUSTMENTS AS NECESSARY.

## STEP 12: CUTTING AND FITTING UNITS AROUND CULVERTS

KEYSTONE UNITS SHALL BE CAREFULLY CUT AND FITTED AROUND HEADWALLS AND CULVERT SECTIONS. THE UNITS SHALL FIT TIGHTLY WITH NO GAPS WIDER THAN 3/4" (20 mm) AND ANY LARGER GAPS OR SPACES SHALL BE GROUTED OR MORTARED PRIOR TO BACKFILLING.  
LEVELING CONCRETE MAY BE REQUIRED WHEN THE WALL UNITS ARE PLACED OVER THE TOP OF HEADWALL OR ARCH TO MAINTAIN THE PROPER ELEVATION OF THE UNIT COURSES. THE THICKNESS OF LEVELING CONCRETE SHALL NOT EXCEED THE THICKNESS OF THE BLOCK (8" (200 mm) UNLESS SPECIAL ANALYSIS REQUIRES A THICKER SECTION.

GEOTEXTILE FILTER FABRIC AND DRAINAGE AGGREGATE SHALL BE PLACED BEHIND ALL KEYSTONE UNIT AND CULVERT INTERFACE JOINTS AS INDICATED IN THE TYPICAL SECTIONS.

## STEP 13: POSITION AND SECURE CAP UNITS

FOLLOW THE SAME PROCEDURES DESCRIBED IN STEP 11 FOR PROPER PLACEMENT AND POSITIONING OF THE KEYSTONE CAP UNITS. A VARIETY OF SIZES AND SHAPES, INCLUDING 4" (100 mm) AND 8" (200 mm) HIGH UNITS, HAVE BEEN DESIGNED TO SATISFY MOST INSTALLATION NEEDS. AVAILABILITY OF THESE UNITS WILL VARY FROM REGION TO REGION. FOR CAP UNIT DESCRIPTIONS AND PLACEMENT VARIATIONS, SEE THE SECTION ON "WALL CAP: USING KEYSTONE UNITS" IN THE DESIGN AND CONSTRUCTION MANUAL.

CAP UNITS MAY BE SECURED WITH A BONDING MATERIAL TO PREVENT THEIR REMOVAL. FINAL ALIGNMENT AT THE TOP OF THE WALL MAY ALSO REQUIRE THIS SAME PROCEDURE. IF DUE TO FINAL ALIGNMENT REPOSITIONED CAP UNITS DO NOT PROPERLY MEET PIN CONNECTIONS, THEN REMOVE THE PINS AND SECURE THESE CAP UNITS WITH THE BONDING MATERIAL. DUE TO THE FLEXIBILITY OR NON-RIGID QUALITIES OF THE KEYSTONE SYSTEM, THE BONDING MATERIAL MUST BE ABLE TO TOLERATE SOME MOVEMENT. KEYSTONE KAPSEAL ADHESIVE IS DESIGNED FOR THIS USE WITH A SPECIAL FORMULATION TO WITHSTAND TEMPERATURE AND MOISTURE EXTREMES. IF THIS MATERIAL IS UNAVAILABLE, OTHER FLEXIBLE EPOXY BASED ADHESIVES DESIGNED TO BOND MASONRY TO MASONRY MAY BE USED. REFER TO MANUFACTURER'S INSTRUCTIONS FOR COMPLETE DETAILS.

## STEP 14: FINISHED GRADE AND LANDSCAPING

THE KEYSTONE RETAINING WALL IS COMPLETE. FINAL GRADING, PLANTING OR OTHER SURFACE MATERIALS CAN NOW BE PUT INTO PLACE. REMEMBER THAT FINISHED GRADE CONDITIONS AFFECT THE WALLS PERFORMANCE. SUCH CONDITIONS SHOULD NOT BE ALTERED FROM THE ORIGINAL DESIGN. LOADING WITH SLOPES, PARKING LOTS AND BUILDINGS SHOULD BE MAINTAINED AS DESIGNED. ANY CHANGES TO THE TOP OF WALL FINISHED GRADE MUST BE EVALUATED PRIOR TO CONSTRUCTION.

## SPECIALIZED CONSTRUCTION TECHNIQUES

THE FOLLOWING ARE A LIST OF SPECIFIC CONSTRUCTION TECHNIQUES THAT MAY BE RELATED TO THE CONSTRUCTION OF A KEYSTONE WALL. SEE OTHER SECTIONS IN THE "DESIGN AND CONSTRUCTION MANUAL" FOR FURTHER DETAILS.

- DRAINAGE ISSUES
- CURBS AND COPINGS
- GUARD RAILS
- WATER APPLICATIONS
- BARRIERS
- TERRACES
- FENCES AND POLES
- LIGHT FIXTURES AND SIGNAGE
- STRUCTURES

## SPECIFICATION GUIDELINES

### PART 1: GENERAL

- 1.01 DESCRIPTION
- WORK INCLUDES FURNISHING AND INSTALLING A KEYSTONE RETAINING WALL TO THE LINES AND GRADES SHOWN ON THE CONSTRUCTION DRAWINGS AND SPECIFIED HEREIN.
  - WORK INCLUDES PREPARING FOUNDATION SOIL, FURNISHING AND INSTALLING THE LEVELING PAD, UNIT FILL AND BACKFILL TO THE LINES AND GRADES SHOWN ON THE CONSTRUCTION DRAWINGS.
  - WORK INCLUDES FURNISHING AND INSTALLING ALL RELATED MATERIALS REQUIRED FOR CONSTRUCTION OF THE RETAINING WALL AS SHOWN ON THE CONSTRUCTION DRAWINGS.
- 1.02 REFERENCE STANDARDS
- ASTM 1372 SEGMENTAL RETAINING WALL UNITS.
  - ASTM D448 SIZES OF AGGREGATE FOR ROAD AND BRIDGE CONSTRUCTION.
  - ASTM D698 LABORATORY COMPACTION CHARACTERISTICS USING STANDARD EFFORT.
- 1.03 QUALITY ASSURANCE
- OWNER WILL BE RESPONSIBLE FOR SOIL TESTING AND INSPECTION QUALITY CONTROL DURING EARTHWORK OPERATIONS.

### PART 2: MATERIALS

- 2.01 DEFINITIONS
- CONCRETE UNITS - A KEYSTONE MODULAR CONCRETE FACING UNIT, MACHINE MADE FROM PORTLAND CEMENT, WATER AND MINERAL AGGREGATES.
  - STRUCTURAL GEOGRID - A STRUCTURAL GEOGRID FORMED BY A REGULAR NETWORK OF INTEGRALLY CONNECTED TENSILE ELEMENTS WITH APERTURES OF SUFFICIENT SIZE TO ALLOW INTERLOCKING WITH SURROUNDING SOIL, ROCK, OR EARTH AND FUNCTION PRIMARILY AS REINFORCEMENT.
  - UNIT FILL - DRAINAGE AGGREGATE WHICH IS PLACED WITHIN AND IMMEDIATELY BEHIND THE MODULAR CONCRETE UNITS.
  - REINFORCED BACKFILL - COMPACTED SOIL WHICH IS WITHIN THE REINFORCED SOIL VOLUME AS SHOWN ON THE PLANS.
- 2.02 KEYSTONE UNITS
- KEYSTONE WALL UNITS SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 3,000 PSI. STANDARD WEIGHT CONCRETE SHALL HAVE A MAXIMUM MOISTURE ABSORPTION OF 8%.
- 2.03 FIBERGLASS CONNECTING PINS
- CONNECTING PINS SHALL BE 1/2" DIAMETER THERMOSET ISOPHTHALIC POLYESTER RESIN-PULTRUDED FIBERGLASS PINS SUPPLIED BY THE MANUFACTURER.
- 2.04 KEYSTONE KAPSEALTM CONSTRUCTION ADHESIVE
- MATERIAL SHALL CONFORM TO ASTM 2339 AND SHALL BE SUPPLIED BY THE KEYSTONE UNIT SUPPLIER.
- 2.05 GEOGRID
- GEOGRID SHALL BE THE TYPE AS SHOWN ON THE DRAWINGS HAVING THE PROPERTY REQUIREMENTS DESCRIBED WITHIN THE MANUFACTURER'S SPECIFICATIONS AND REQUIRED BY THE DESIGN.
- 2.06 BASE LEVELING AND PAD MATERIAL
- MATERIAL SHALL CONSIST OF COMPACTED CRUSHED STONE OR UNREINFORCED CONCRETE AS SHOWN ON THE CONSTRUCTION DRAWING.
- 2.07 UNIT DRAINAGE FILL
- UNIT FILL SHALL CONSIST OF CLEAN 1" MINUS CRUSHED STONE OR CRUSHED GRAVEL MEETING THE FOLLOWING GRADATION:

SIEVE SIZE	%PASSING
2"	100
3/4"	75-100
No. 4	0-10
No. 50	0-5
- 2.08 REINFORCED BACKFILL
- REINFORCED BACKFILL SHALL BE FREE OF DEBRIS OR ORGANIC MATERIAL MEETING THE FOLLOWING GRADATION:

SIEVE SIZE	%PASSING
2"	100
3/4"	100-75
No. 40	0-6
No. 200	0-15
  - PLASTICITY INDEX (PI)<6
  - THE MAXIMUM AGGREGATE SIZE SHALL BE LIMITED TO 2" UNLESS FIELD TESTS HAVE BEEN PERFORMED TO EVALUATE POTENTIAL STRENGTH REDUCTION TO INSTALLATION.
  - MATERIAL CAN BE SITE EXCAVATED MATERIAL WHEN THE ABOVE REQUIREMENTS ARE MET. UNSUITABLE SOILS FOR BACKFILL (HIGH PLASTIC CLAYS OR ORGANIC MATERIALS) SHALL NOT BE USED IN THE REINFORCED SOIL MASS.
  - CONTRACTOR SHALL SUBMIT REINFORCED FILL SAMPLE AND TEST RESULTS TO THE ARCHITECT/ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION.

DESIGN IS FOR INTERNAL STABILITY OF THE KEYSTONE WALL STRUCTURE ONLY. EXTERNAL STABILITY, INCLUDING BUT NOT LIMITED TO FOUNDATION AND SLOPE STABILITY, IS THE RESPONSIBILITY OF THE OWNER. THE DESIGN IS BASED ON THE ASSUMPTION THAT THE MATERIAL WITHIN THE RETAINED MASS, METHODS OF CONSTRUCTION, AND QUALITY OF MATERIALS CONFORM TO KEYSTONE'S SPECIFICATIONS FOR THIS PROJECT.  
  
THIS DRAWING IS BEING FURNISHED FOR THIS SPECIFIC PROJECT ONLY. ANY PARTY ACCEPTING THIS DOCUMENT DOES SO IN CONFIDENCE AND AGREES THAT IT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART, NOR DISCLOSED TO OTHERS WITHOUT THE CONSENT OF KEYSTONE RETAINING WALL SYSTEMS, INC.

No.	Date	Revision	By

**KEYSTONE**  
RETAINING WALL SYSTEMS  
4444 West 78th Street  
Minneapolis, MN 55435  
(612) 897-1040

Designed By: **RKM**  
Checked By: **CDM**  
Date: **08/08/00**

Client: **CONTECH CONSTRUCTION PRODUCTS INC.**  
Scale: **AS NOTED**

Title: **KEYSTONE INSTALLATION NOTES & SPECIFICATIONS**  
Project No:   
Drawing No: **7**