Notes for Erection of Evergreen Maxi Wall Retaining Walls

1. Evergreen Maxi General Notes

A. **Project drawings -** See project drawings for complete layout of utilities, railroad tracks, existing and proposed structures etc.

B. **Designer - …**

C. **System, Trademark, and Patent holder -** International Evergreen Team, Evergreen Walls, Inc., 6069 Oakbrook Parkway, Norcross, Georgia 30093, USA, Phone 770 840 7060, Fax 770 840 70690- , EVERGREEN®, Felix P. Jaecklin, PE, Dipl. Ing., Dr. sc. tech. ETH, Geissbergstr. 46, CH-5408 Ennetbaden, Switzerland, phone +4156 222 0724, cell +4179 356 0081, jaecklinfelix@netwings.ch., www.evergreenwalls.com.

D. **Precaster and Supplier –**.

E. **Precast Evergreen Units -** Supplied by the precaster.

F. **Precast Shear Resistance –** Vertical dowels inserted during erection and self aligning devices built into the units.

G. **Cast in Place Leveling Pads -** Constructed by the contractor, 0.15 x 0.40 m , 6 inches x 18 inches wide, with steel reinforcement, grade 60, and limits for tolerance: zero above, 0.01m. ½ inches below design elevation, add mortar bed for preventing load concentrations before setting unit.

H. **Horizontal Joints –** 0.25 cm, 1 inch spacing with tolerance +/- 0.25 cm, 1/8 inch tolerance for mortar. Place mortar before setting units at all horizontal joints less than 2.80 m, 10 ft. below crest of wall units. (No mortar joints in upper 3m except for board units).

I. **Vertical Joints –** 2 cm, 1 inch nominal spacing. Use a piece of wood when erecting a unit, then remove wood immediately. Place geotextile, about 0.3 m, 12 inches wide, behind vertical joints to prevent washout of fines during heavy rains.

J. **Construction -** See Evergreen erection instructions**.**

K. **Overall Construction Tolerances for Finished Wall -** Vertical alignment - (plumpness) 2 cm, 1 inch in 3.0m, 10 ft. and 1cm, ½ inch in 5m, 10 ft. between adjacent panels.

2. Evergreen Maxi Material Notes

A. Concrete - Precast Evergreen® units – 350 kg/cm2. 5000 psi at 28 days, allowable :
- compression at edge fc = 14 N/mm2 = 140 kg/cm2, 2000 psi
- compression at center fc = 8.75 N/mm2 = 87.5 kg/cm2, 1250 psi
- shear vc = 0.65 N/mm2 = 6.5 kg/cm2. 95 psi
- Precast shear keys built in of same quality - CIP Leveling Pad 210 kg/cm2, 3000 psi.
- use chlorine and or sulfate resistant cement and design concrete mix to resist local chemical properties of soil and fill materials.

B. Reinforcing Steel - Precast Evergreen® units
- yield strength fy = min. 460 N/mm2 = 4600 kg/cm2 ; 60 ksi
- allowable fs = min. = 256 N/mm2 = 2560 kg/cm2, 24 ksi. Use standard high strength steel for meshes.

C. Joint Material - Vertical Joints – 12 mm wide, place filter fabric centered behind joint.
- Horizontal Joints - layer of wet joint filler consisting of 1/3 cement, 1/3 sand, 1/3 water for eliminating load concentrations and providing friction. Place geotextile filter fabric min 3.0m, 12 inches wide, resistant to extended UV radiation, min. 200 g/m2, 0.04 lbs/sf centered at joint on the back of

Evergreen panels.
- Shear Resistance between units – Vertical dowels between units inserted during erections and self alignment keys built into the units at ends and at centers of front panels.

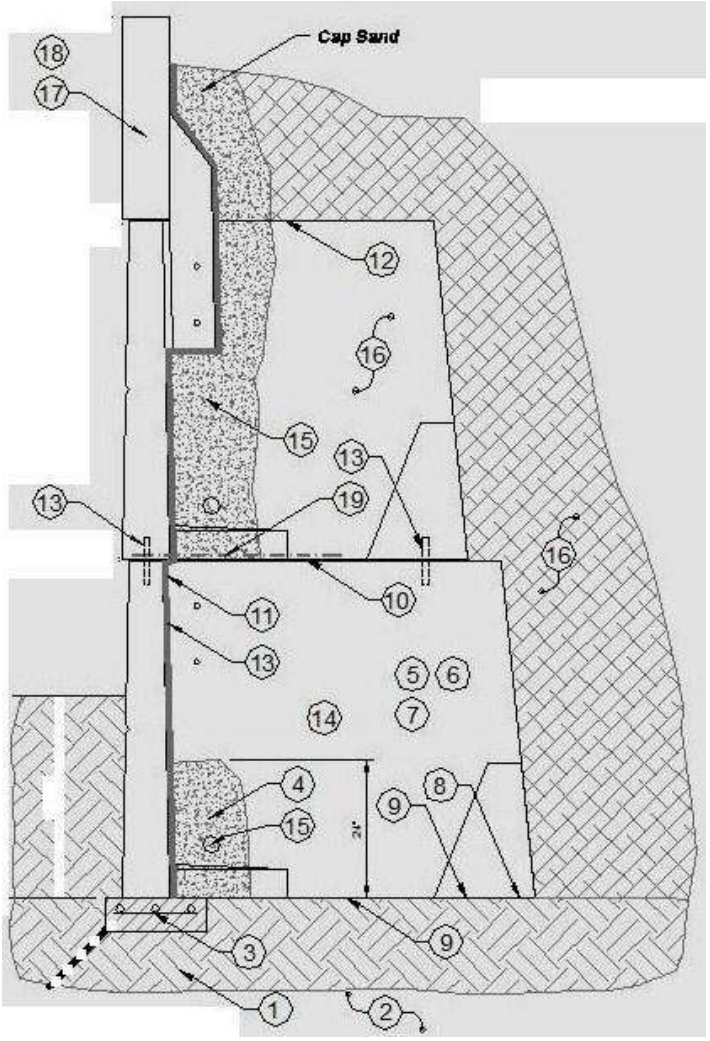
D. Fill Inside of Units - Use a min. 0.30m, 12 inches of free draining material next to the front face for preventing water back-up and undrained direct freezing. For the bulk of the fill use regular backfill material, provided fill material shall have Plasticity Index below 6. - This means that silt or clay materials are not acceptable, for their poor compaction and drainage capabilities.

No select fill is required, provided the fill material inside of precast units is max. ± 2% off optimum water content and provided it reaches a friction angle after compaction of min. phi = 32° degrees. - Fill in lifts of about 0.35 to 0.4 m, 12 inches to 18 inches thus min. 4 lifts per unit.

Compact to min. moist density of 18 kN/m3 = 1.8 t/m3, 113 pcf which may result in min. 90%, max. 95% relative density measured at the center of the units. Note that minimum compaction requirement is moist density and NOT relative density or proctor density.

Note that important fill and backfill materials are internal friction angle and moist density, not relative or Proctor density, since this is a gravity wall, not depending on steel strip friction and the like.

3. Typical Evergreen Maxi Section



4. Evergreen Maxi Erection Instructions

1. **Foundation Excavation and Foundation Preparation** - Excavation must reach well bearing soil. Any loose or otherwise foreign or mixed in material must be removed generously. Excavate deeper and as needed and as approved by the engineer. This applies particularly next to the toe of the wall and within a 1:1 line down from the front toe of the leveling pad and this applies for a depth of minimum 0.60m, 2 ft measured from the top of the leveling pad. Use well graded sand or gravel or crushed rock aggregate or any other means to limit settlement of the front part of the wall from 'soil-structure-interaction' as defined by the engineer and the geotechnical consultant. Use very heavy vibratory compactors for through compaction of 'near surface sub-ground', min. 95% modified compaction. A very high degree of cooperation is encouraged and must be monitored by using nuclear gauges or similar efficient and quick testing.

2. **Sub-Ground Requirements -** Minimum requirement material beneath foundation depends on project design as shown in the typical drawing (friction angle phi = 32°, cohesion c' = 0, gamma moist = 20 kN/m3 = 2.00 t/m3, 125 pcf). Excavate to the top of the area be covered by Evergreen wall. Then compact sub grade to 95% modified proctor density (AASHTO T180), or provide foundation remediation as directed by the supervising geotechnical engineer.
   The sub grade level of the wall and embankment shall be proof rolled prior to backfill of wall locations. Unstable areas discovered during proof rolling shall be compacted to suitable state or undercut and replaced with compacted, well graded granular fill as directed by the Engineer.
   Any soft, wet or organic or otherwise unsuited material encountered in the footing area shall be removed and replaced with a minimum of 0.6 m of fill of clean sandy gravel or crushed rock aggregate or lean concrete, or clean gravel placed and compacted in 0.30m, 1 ft. lifts. Crushed aggregate must extend much further out to meet the spreading at an angle 1v:1h or minimum 2v:1h. Place a drain pipe into such soil improvement wherever a ditch or drain outlet is in feasible distance and elevation.

3. **Leveling Pads -** Then excavate and pour concrete foundation leveling pad on full front face with min. 210 kg/cm2, 2000 psf standard compressive concrete strength and one layer of grade 60 rebars. Place reinforcing bars as specified and cast concrete directly against excavation with finished top to ensure proper grade and elevation. Tolerance limits of top elevation are zero over and minus 1 cm, ½ inch max.

4. **Drain Pipe** - In areas near a ditch or drain outlet place a continuous foundation drain min. 100mm diameter PVC pipe, or approved equal with longitudinal grade min. 0.5% and add min. of 0.30 m, 12 inches of free draining material covered by a geotextile.

5. **Unit Handling -** Order units on fully loaded trailer trucks for unloading directly onto foundations or for direct erection. Waiting of units sitting on trailers is OK, yet site storage on soil is NOT recommended. Should it still be necessary cases, then store units on THREE wooden blocks, two blocks spread wide apart under one leg and a single block centered under the other leg. This avoids torsion and subsequent fissuring and or creep deformation of units. Stockyard storage should use the same three point type loading.

6. **Start Erection -** Start erection of each wall directly adjacent to bridge abutments, next to existing structures, next to culverts, or at lowest foundation elevation, as indicated on the drawings. Select such starting point for erection to easy adjustment and alignment and for minimizing differentia settlement effects. Wall units between next to bridge abutments should be placed first, and then adjusted to make sure the length of wall matches and any tolerance will be picked up by spreading the joint width accordingly; after adjusting fill and compact.

7. **Wider Joints Near Culverts, Softer Sub-ground –** Open up width of space between vertical joints of units from 2 cm to 3 or 4 cm in case of softer sub-ground reaction or locally excessive settlement expected for giving units extra space for lateral settlement reaction without undue stress.

8. **Wall Batter Adjustments -** Theoretically walls are designed to stand vertical after erection with front face units flush. Lowest Evergreen unit shall be adjusted with small wooden wedges using engineer's level to set front parts level and legs at slant for proper wall batter if applicable within 3mm 1/8 inch tolerance. Consider future slight turning of gravity walls during backfilling, compaction and settlement during and after construction by placing the wall with a minimum batter, correcting itself to some extent by natural settlement and backfilling operation. Use 4 long wooden wedges from both sides of legs to lift units from both sides for lifting and slight shifting of units to adjust with neighboring units, levels and slight wall batter (as to be demonstrated).

9. **Shims –** Use wooden wedges to adjust Evergreen units for elevation and slant. Plastic, Neoprene or steel shims or any other material are absolutely NOT allowed, since such material is more slippery than

concrete and mortar (friction angle min. 35°). Besides such material may keep transferring permanent loads instead of transferring such loads through the mortar after wood dries or deteriorates after some time. Wooden wedges can be removed after mortar setting, yet need NOT to be removed.

Mortar Beds for First Unit - Place first unit on **DRY PACK FAST SET mortar** if adjustment for the first layer is more than 6mm. - If foundation level was built within a tolerance of +/-6mm under design elevation, then use wooden wedges and **THIN** mortar beds pushed under the front facing and under the legs until mortar comes out on the opposite side. Use mortar beds under full length of legs and back beams; for front facing use 0.60m of mortar bed at ends, 0.60m, 2 ft. centered at legs and 1.20m, 4 ft. of mortar bed at center of facing. This allows for three intermediate gaps for water weeping at the facing.

10. **Mortar Beds for Upper Units -** Use mortar beds to assure proper load transfer and no load concentrations from uneven contact surfaces or small rocks for preventing splitting of units.
    Mortar beds should be anywhere between zero and 12mm, ½ inch for adjustment, use relatively thin or liquid mortar on upper lifts to ease erection and for avoiding load concentrations. Use stiff mortar for thicker joints together with wooden wedges as needed. Use mortar beds under full length of legs and back beams; for front facing use mortar beds 0.6 m, 2 ft. at ends, 0.6 m, 2 ft. entered at legs and 1.20 m 4 ft. centered in the middle. This allows for water weeping at the joints of the facing.

11. **Geotextile to Cover Joints** - Cover the inside of vertical joints between adjacent units and non mortared horizontal parts of horizontal joints before backfilling with geotextile pieces to prevent loss of fill material from washouts.

12. **No Mortar Beds in Joints about 3.0 m from the Top -** Upper units, less than 3.0 m, 10 ft. from the top do NOT need mortar beds, yet geotextile cover inside. Drainage water from inside or behind units may seep out through open vertical joints, covered with geotextile for preventing washouts.

13. **Vertical Dowels - Fill** box-outs with mortar, then vertical dowels on top of erected units, normally 4 dowels 16 mm, #5 bars, 20 cm, 8 inches long. Front dowel box-outs are 10 cm, 4 inches deep, so dowels will show 10 cm, 4 inches, further back box-outs are 12.5 cm, 5 inches deep, so dowels will show about 7.5 cm, 3 inches. This allows for easy alignment along the facing first, then lower unit 2.5 cm, 1 inch and aligns the back.

14. **Compact Fill Inside of Units First -** The Evergreen wall and the backfill shall be built up simultaneously. Always fill inside of units first and compact, then backfill behind units and compact, for preventing elements from sliding. It is desirable to keep the elevation of the fill behind the wall within about 75 cm, 2.5 ft. at any time.

15. **Wall Drainage -** Remove debris and topsoil before backfilling. Since these retaining walls are in a rather flat topography, not following a mountain side, the seepage anticipated is rain and surface water from the top or in low spots along the toe of the wall. - The drainage concept consists of 0.30 m, 12 inches min. thickness vertical layer of free draining sandy material directly behind the wall front facing on the full height of the wall, except the lowest unit, connecting to open vertical joints and to the gaps in horizontal joints for weeping. The lowest unit has a similar drainage behind the facing, yet only 0.6m, 2 ft. high for preventing water back-up in the foundation area and for providing positive weeping of any surface water above the first unit. - Originally planned drainage pipes along the entire heal of each wall will be replaced by (relatively short) longitudinal drains and transverse drain pipes near low spots and next to culverts. - The engineer will determine locations of such drains during construction and may add additional drains at low spots.

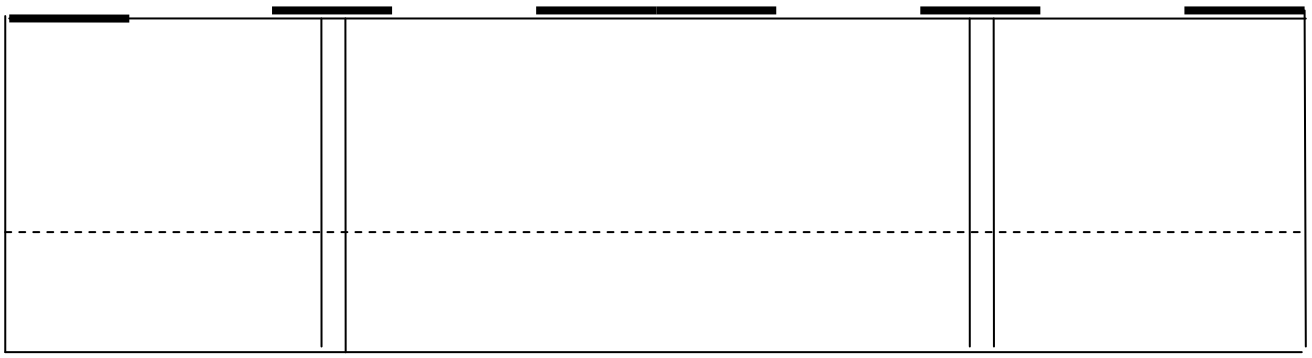
16. **General Fill and Backfill Requirements** - Fill in lifts of max.0.40 m, 1.5 ft., at max. $\pm$ 2% off optimum water content and compact to moist density min. 18 kN/m3. This may represent about 90, max. 95% relative density inside of units and within 0.90 m, 3 ft. of back of wall facing. Do not use heavy equipment inside and within 0.90 m, 3 ft. from the back of the wall. Further away compact with heavy equipment to min. 95%, max. 98% relative density. Soil properties of backfill must conform to minimum requirements of design as shown on the typical section (friction angle phi' = min. 32°, cohesion c' = 0, gamma moist = min. 19 kN/m3, 118 pcf).

17. **Board Units -** Erect board units after placing mortar beds on horizontal joints and insert immediately horizontal, galvanized dowels for keeping board units in place. Us small wooden wedges as needed. These dowels secure board units permanently and must be hot dipped galvanized; ASTM-A 123.

18. Parapets - Erect parapet units the same way. However horizontal dowels replace temporary bracing and need NOT to be galvanized. Horizontal and vertical alignment of parapets is very critical; adjust carefully by wooden wedges and fix positions as needed by mortar beds and/or casting small amounts of concrete around the 'legs' of the parapets. Brush and clean top of Evergreen legs for permanent and proper parapet positions. Insert vertical dowels into legs of Evergreen units to ensure proper safety of parapets against sliding on top of Evergreen units. Then place connecting reinforcing steel for foundation and moment resistance and cast in place parapet foundation concrete.

Mortar Joint Locations (on Top of Each Evergreen Maxi Unit)

0.60 m at end 2 ft. at end	0.60 m centered at leg 2 ft. centered at leg	1.20 m centered at center 4 ft. centered at center	0.60 m centered at leg 2 ft. centered at leg	0.60 m at end. 2 ft. at end.



Front face of Evergreen Maxi 6.00 x 1.50 m, 20 x 5 ft. **Dashed line: back beam, not seen**