

# Construction Specifications

## Earth Retention

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### PART 1 GENERAL

#### 1.01 SECTION INCLUDES

- A. The work covered by this section includes the furnishing of all labor, materials, equipment and incidentals for construction and installation of the Geocellular Confinement System as shown on the Construction Drawings and described by the Contract Specifications.
- B. Use of the Geocellular Confinement System to mechanically restrain the near surface zone of steep slopes which could otherwise slide due to self-weight or applied tractive loads. Applications include surface protection of steep reinforced-soil slopes, vegetated slope covers and protective covers on geomembrane slope installations.
- C. Products and materials which form the system include: The cellular confinement sections, select infill materials, woven & nonwoven geotextiles, drainage composites, surface treatments, integral tendons, straight stake rebar anchors, galvanized staples.

#### 1.02 RELATED WORK

- A. Section [ ] - Earthwork, Subgrade preparation.
- B. Section [ ] - Subsurface Drainage. Install drainage materials, as required, in areas where in-situ soils have poor permeability.

#### 1.03 REFERENCES

- A. AASHTO Specification M-288-00, ASTM D-1557 and relevant CSI (Construction Specifications Institute) Spec Data Documentation.
- B. American Society for Testing and Materials (ASTM).
- C. International Organization For Standardization (ISO).

- D. Manufacturer's Technical Notes and Design and Installation Guidelines.

#### 1.04 QUALITY ASSURANCE AND CERTIFICATION

- A. Soil Stabilization Products Company, Inc. shall provide certification of compliance to all applicable testing procedures and related specifications upon written request. Request for certification shall be submitted no later than the date of order placement.
- B. Soil Stabilization Products Company, Inc. shall have earned a certificate of registration, which demonstrates that its Total Quality Management system (TQM) for its Geocellular Confinement System is currently registered to the ISO 9002 quality standards (or latest ISO standard). The scope of the ISO 9002 registration shall be for the entire Geocellular Confinement System product manufacturing process from incoming raw materials (resin) to finished product. Earned registration shall be verifiable by providing a copy of the current continuous registration certificate upon the customers written request.
- C. Material Substitutions: No material will be considered as an equivalent to the geocell materials specified herein unless it meets all areas of this specification without exception. Manufacturers seeking to supply what they represent as equivalent material must submit records, data, independent testing results, samples, certifications, and documentation deemed necessary by the Engineer to prove equivalency. The Engineer shall approve or disapprove other manufacturers materials within 60 days after all submitted information is studied and tested.

#### 1.05 SYSTEM DESCRIPTION

- A. Geocellular Confinement System consists of geocell material into which specific infill material may be placed. The Geocellular Confinement System section is an assembly of high-density polyethylene sheet strips,

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connected by a series of ultrasonic welded seams. When expanded, the interconnected strips form the walls of a flexible, three-dimensional, honeycomb like, cellular structure.

- B. The Geocellular Confinement System is produced in a range of cell depths. Standard cell depths are: 75 mm (3 in.), 100 mm (4 in.), 150 mm (6 in.) & 200 mm (8 in.)

### 1.06 SUBMITTALS

- A. Submit shop drawings.
- B. Submit product data, drawings and samples.
- C. Soil Stabilization Products Company, Inc. shall provide a Manufacturer Qualified Representative (MQR) on site at the start of construction to provide the installing contractor and Project Engineer with technical support and information regarding installation of the Geocellular Confinement System. The MQR shall document a minimum of 5 years experience assisting with the installation of Geocellular Confinement Systems.

Submit qualifications of MQR. Request for qualifications of the MQR shall be submitted by the purchasing agency to Soil Stabilization Products Company, Inc. or the manufacturer's representative no later than the date of order placement. MQR's submittal shall include a written certification verifying that the MQR has completed a minimum of one manufacturer-sponsored technical training course of minimum duration of 20 hours in the design principles and installation practices of Geocellular Confinement Systems. The certificate submitted must show the name of the qualifying MQR, give the date and location where the training occurred and be signed by an authorized representative of Soil Stabilization Products Company, Inc. (the manufacturer). Availability of MQR personnel shall be subject to scheduling, fees for travel and per diem expenses.

- D. Soil Stabilization Products Company, Inc. shall have earned a certificate of registration, which demonstrates that its quality-management system for

its Geocellular Confinement System is currently registered to the ISO 9002 quality standards. The scope of the ISO 9002 registration shall be for the entire Geocellular Confinement System product manufacturing process from incoming raw materials (resin) to finished product. Earned registration shall be verifiable by providing a copy of the current continuous registration certificate upon the customer's written request. Under the scope of the ISO quality standard, Soil Stabilization Products Company, Inc. shall compile, keep record of, and provide for each customer order or production lot, actual and certified values for the following:

1. Resin Lot Number
2. Resin Density
3. Carbon Black content (where applicable)
4. High Pressure Oxidation Induction Time (HPOIT) (where applicable)
5. Sheet Thickness
6. Short-term Seam Peel Strength
7. Long-term Seam Peel Strength
  - i. 7-day hot box method
8. 10,000 hour hang strength test

## PART 2 PRODUCTS

### 2.01 MANUFACTURER and AVAILABILITY

- A. SSP Geocell is supplied by Soil Stabilization Products Co., Inc., PO Box 2779, Merced, CA 95344. Phone: (800) 523-9992.

### 2.02 CELLULAR CONFINEMENT SYSTEM

- A. Polyethylene Composition and System Properties

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PROPERTY	Value & Test Method
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- 1) Resin Density 0.935 - 0.960 g/cm<sup>2</sup> (58.4-60.2 lb/ft<sup>2</sup>) per ASTM D 1505. Performed by Resin manufacturer. Results are verified on Certificate of Analysis that accompanies each lot number of resin received. samples and varying loads to generate data indicating that the seam peel strength shall support a loading of at least 52 kg (115 lbf) for a minimum of 10,000 hours without failure.
- 2) Carbon Black Content 1.5 - 2.0% by weight through the addition of a carrier with a certified carbon black content. Tested during manufacturing every 15,800 ft<sup>2</sup> of 203 mm (8.0 in) cell depth, every 20,000 ft<sup>2</sup> of 150 mm (6.0 in) cell depth, every 31,600 ft<sup>2</sup> of 102 mm (4.0 in) cell depth and every 40,000 ft<sup>2</sup> of 75 mm (3.0 in) cell depth.
- 3) Sheet Thickness 1.27 mm (50 mil) -5% + 10% per ASTM D 5199. Tested during manufacturing every 2,900 ft<sup>2</sup> of 203 mm (8.0 in) cell depth, every 3,800 ft<sup>2</sup> of 150 mm (6.0 in) cell depth, every 5,800 ft<sup>2</sup> of 102 mm (4.0 in) cell depth and every 7,600 ft<sup>2</sup> of 75 mm (3.0 in) cell depth.
- 4) Resin ESCR Minimum 3000 hours per ASTM D374. Performed by Resin manufacturer. ESCR = Environmental Stress Crack Resistance
- 5) Short-Term Seam Peel Strength See Appendix A.
- 6) Long-Term Seam Peel Strength See Appendix B.
- 7) 10,000 hour hang strength The manufacturer shall provide data showing that the high-density polyethylene resin used to produce the geocell sections has been tested using an appropriate number of seam
- B. Surface Treatment**  
Performance: The peak friction angle between the surface of the perforated, textured plastic and a #40 silica sand at 100% relative density shall be no less than 85% of the peak friction angle of the silica sand in isolation when tested by the direct shear method per ASTM D 5321. The quantity of perforations shall remove 22.1% ± 0.5% of the cell wall area.  
  
Material: The surface texturing shall be a multitude of rhomboidal (diamond shape) indentations. The rhomboidal indentations shall have a surface density of 22 - 31 per cm<sup>2</sup> (140 - 200 per in<sup>2</sup>). The thickness of the textured sheet shall be 1.52 mm ± 0.15 mm (60 mil ± 6 mil) determined per ASTM D5199. The perforations shall be horizontal rows of 10 mm (0.391 in) diameter holes. Perforations within each row shall be 19 mm (0.75 in) on-center. Horizontal rows shall be staggered and separated 12 mm (0.50 in) relative to the hole centers. The edge of strip to the nearest edge of perforation shall be 8 mm (0.312 in) minimum and the centerline of the weld to the nearest edge of perforation shall be 18 mm (0.7 in) minimum.
- C. Assembly**  
Standard Cellular Confinement System sections are fabricated using strips of sheet polyethylene each having a length of 3.61 m (142 in) and a width equal to the cell depth. The polyethylene strips shall be connected using uniformly-spaced, full-depth ultrasonic spot-welds. Welds shall be off-set and aligned perpendicular to the longitudinal axis of the strips. Weld spacing shall be 356 mm ± 2.5 mm (14 in. ± 0.10 in). The ultrasonic weld melt-pool width shall not exceed 25 mm (1.0 in).  
  
Cellular confinement sections shall be made from high density polyethylene plastic. The polyethylene shall have properties per paragraph A above.

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### D. Geocell Dimensions and Weights

- Individual cells of the standard Geocell section shall be uniform in shape and size when expanded. The nominal cell dimension, in expanded configuration, shall measure 8.6" (218 mm) in length (in the direction of expansion) with 0.25" (6 mm) tolerance and 10.5" (267 mm) in width. Expanded section size is 8.7' (2.65 m) x 24.25' (7.39 m).

- Cell Area: 47.9 in (309 cm) cell expanded (nominal area)
- Product Code: GC 20V61034P
- Cell depth: 6.0" (150 mm)
- Section weight: 85.21 lb (38.65 kg)
- Section width: 8.7 ft (2.65 m)
- Section length: 24.25 ft (7.39 m)

### 2.03 ANCHORING COMPONENTS

#### A. Integral High-Tenacity Polymer Tendons

Where required in project plans and specifications, Geocellular Confinement System sections shall be supplied with a series of aligned holes, pre-formed in the cell walls, to accommodate insertion of polymer tendons throughout their length.

- B.** Standard tendons shall be manufactured from bright, high-tenacity, industrial-continuous-filament polyester yarn woven into a braided strap. Elongation shall be 9-15% at break. The maximum and minimum dimensions of the tendon shall be given in addition to its minimum break strength. The tendon reference name and ultimate break strength shall be per the following:

Product:	Min. Break strength	Infill Type Notes
TP-31	700 lbs	May not be used with Concrete Infills
TPP-44	990 lbs	May not be used with Concrete Infills
TP-67	1506 lbs	May not be used with Concrete Infills
TK-89	2000 lbs	May be used with Concrete Infills
TP-93	2090 lbs	May be used with Concrete Infills
TK-133	3000 lbs	May be used with Concrete Infills

#### C. Straight Stake Anchors

Standard #4 steel construction rebar, diameter of 12.7 mm (1/2"). Project plans and specifications may call for

alternate anchor types depending upon design requirements (e.g., GFRP anchors which may be specified for critical applications and severe service environments).

### 2.04 RELATED GEOSYNTHETIC COMPONENTS

#### A. Geotextiles

Geotextile materials shall meet appropriate durability, long-term strength, and soil interaction requirements. In the absence of local design and selection standards, the recommendations given in AASHTO M 288-00 shall be followed.

#### B. Geo-composite Drainage Systems

Geo-composite drainage systems, including geotextile wrapped perforated pipes and sheet drainage cores, may be incorporated as sub-drains and interceptor drains. Product selection and application shall be determined by the design engineer.

#### C. Geogrid and Geotextile Sheet Reinforcement

Sheet reinforcement materials shall meet appropriate durability, long-term strength, and soil interaction requirements. In the absence of local design and selection standards, the recommendations given in AASHTO M 288-00 shall be followed.

### 2.05 CELL INFILL MATERIALS

- A.** Selection of infill materials is based primarily on the nature and magnitude of design loads. Combinations of infill types can be specified to meet a range of performance requirements. The gradation, quality, and ease of placement and compaction of the infill material influence the design and stability of the structure. Use of consistent fills with high internal friction angles will generally produce the most efficient structures. Clays, silts, and organic soils are not acceptable infill materials for the internal cells of retaining walls and multi-layer retention structures.

- B.** Standard infill materials for the interior cells of the Cellular Confinement System sections include sand, gravel, and crushed rock with maximum particle size of 2 inches, as required by project specific conditions or as required by project specifications and drawings.

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- C. For walls and multi-layer retention structures, the exposed outer cells may be infilled with topsoil and seeded or planted to support vegetative growth. Clear stone, poured or pumped concrete, or soil-cement mixes can be used to suit specific functional, hydraulic or aesthetic requirements.
- D. See note 2.03 A for special tendon requirements where tendons will be placed within concrete infill.

### 2.06 SURFACE TREATMENTS

- 1. Degradable re-vegetation blankets.
- 2. Sprayed emulsions and binders.
- 3. Concrete and soil-cement mixes.
- 4. Grass seed or vegetation

## PART 3 INSTALLATION

### 3.01 EXAMINATION

- A. Verify that site conditions are as indicated on Construction Drawings.
- B. Verify that layout of the proposed wall structure is in accordance with Construction Drawings.
- C. Verify that all materials required for the work and delivered to site comply with Contract Specifications.

### 3.02 SITE and SUBGRADE PREPARATION

- A. Following bulk excavation and fill placement operations, shape and compact the subgrade surfaces to the profiles, lines and grades shown on the Construction Drawings.
- B. Remove unstable subgrade soils and replace with approved compacted fill.
- C. Install the specified geotextile under layer on the prepared surfaces, ensuring that required overlaps are maintained and that the outer edges of the geotextile are buried at least 150mm (6") below grade to prevent uncontrolled flow of surface runoff below the geotextile.

### 3.03 BASE and SPREAD FOOTING INSTALLATION

- A. Where specified, install a suitable geotextile separation layer prior to placement of the base material. Follow project plans and specifications for material placement.
- B. Place, shape and compact specified granular base materials to the line and grade shown on the construction drawings. Compact the base material to a minimum 90% Modified Proctor Dry Density (ASTM D-1557).
- C. If drainage is necessary, place drainage composites and/or pipes as required.
- D. Expand the specified Cellular Confinement System footing sections, dimensioned according to construction drawings, into designated position on the prepared base. Hold individual section open in the expanded position and temporarily anchor at corners and edges using rebar stakes or stretcher frames.
- E. Overfill the cells with the specified granular infill material and level the surface to approximately one 25 mm (1) in. above cell walls. Compact the infill material to a minimum 90% Modified Proctor Dry Density (ASTM D-1557) and flush with the top of cell walls, using conventional compaction equipment and methods appropriate for the specified infill type.
- F. Place backfill material around perimeter of Cellular Confinement System footing sections and compact as appropriate. Ensure that placement of this material does not conflict with placement of drainage system.

### 3.04 DRAINAGE SYSTEM INSTALLATION

- A. Install the specified subdrain pipe(s) at the location and elevation shown on the construction drawings, ensuring that a minimum gradient of 1% is maintained to all free outlets.
- B. Ensure that all pipe connections are properly made and that the subdrain pipe is connected to outlet pipes or an existing and functional subsurface drainage system. Encapsulate the subdrain pipe, where specified, with geotextile wrapped bedding material (e.g. a "burrito wrap" of sand, pea gravel, clear stone, etc.). Compact all fill placed against the drainage system.

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- C. Wrap all large diameter outlet pipes passing through the wall face with geotextile fabric to prevent loss of the cell infill material. A 50 mm (2") diameter PVC outlet pipe can be placed through a cell section by drilling an appropriate sized hole in the collapsed section, prior to the expansion and cell infill procedure outlined in section 3.03 above. Finally, ensure that discharge at the outlet end will not cause localized erosion that may impact the stability of the wall foundation layer.
- D. Place geotextile, if specified, over base and extend up the back of the excavation and pin into position. Ensure that adequate overlaps are maintained between sections of geotextile. Where geo composite sheet drainage materials are specified, ensure that each strip is continuous and fully encapsulated with geotextile, and that unrestricted outlet is provided.
- D. Placement of Cell Infill Material: Depending on site access conditions and available equipment for placing infill, sections can be filled as each section is expanded into position or infill placement can begin after a continuous layer of cell sections are expanded, staked and stapled into position. The equipment operator should limit drop height of infill materials to a maximum of 0.9 m (3 ft) during placement. Overfill the cells with the specified granular infill material and level the surface to approximately 25 mm (1 in.) above cell walls. If site conditions require that material handling equipment traffic over the Cellular Confinement System sections, the operator must maintain sufficient granular cover to prevent damage to the cell walls.
- E. Compact the cell infill material to a minimum 90% Modified Proctor Dry Density (ASTM D-1557) and flush with the top of cell walls, using conventional compaction equipment and methods appropriate for the specified infill type. Lighter, walk-behind compaction equipment is preferred on the cell section so as to avoid outward lateral displacement of the section or distortion of a particular cell.

### 3.05 INSTALLATION OF CELLULAR CONFINEMENT SYSTEM WALL AND FASCIA SECTIONS: INFILL PLACEMENT

- A. Expand specified Cellular Confinement System sections, dimensioned according to construction drawings, into designated position. Hold individual section open in the expanded position using one of the following options. Other options are also acceptable:
  - 1. Rebar U-Clips, dimensioned according to section width and positioned inside selected outer cell walls.
  - 2. Straight Rebar Stakes
  - 3. Stretcher Frames, assembled from common construction materials.
- B. Confirm that each cell section is expanded uniformly to required dimensions and that outer cells are correctly aligned. Full expansion of the wall sections will result in better looking wall.
- C. Align and inter-leaf or butt joint the edges of adjacent sections according to which sidewall profiles abut. In all cases, ensure that the upper surfaces of adjoining Cellular Confinement System sections are flush at the top of joint. Fasten the adjoining sections together with staples or as specified in construction drawings.
- F. Place specified backfill material behind Cellular Confinement System wall and fascia sections and compact to a minimum 90% Modified Proctor Dry Density (ASTM D-1557). In cut areas, extend the backfill to the limit of the cut slope. In fill areas, place backfill materials as specified on the construction drawings. Heavy compaction equipment can be used to compact backfill materials to within 0.9 m (3 ft) of the Cellular Confinement System wall or fascia section. As stated above, use lighter walk-behind compaction equipment to compact backfill materials directly behind the wall sections. Outward lateral displacement of the cell wall section is an indication that excessive compaction is occurring.
- G. When positioning the next layer, ensure that the proper setback for each layer is established per contract drawings and that the overall batter of the Cellular Confinement System wall face is maintained. In addition, proper side-to-side cell alignment needs to be maintained to prevent loss of cell infill material.

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- H. After compaction of each layer, remove excess infill materials flush to the top of the cell walls. The top of the cellular structure should be visible.
- I. Place, fill and compact subsequent layers according to steps A through H.

### 3.06 INSTALLATION of GEOSYNTHETIC REINFORCEMENT and BACKFILL (whenever specified)

- A. Place precut sections of geosynthetic reinforcement (geogrids or woven geotextile fabrics), dimensioned and oriented according to project plans and specifications, between specified Cellular Confinement System layers. It is important that reinforcement layers are:
  - 1. Placed horizontally, with the high-strength axis perpendicular to wall face.
  - 2. Placed flat and free from folds.
  - 3. Placed so that leading edge is within 152 mm (6 in) of the front face of wall section and extended horizontally into the compacted backfill zone.
- B. Place, infill and compact the next Cellular Confinement System fascia layer as described above in section 3.05.
- C. Manually tension the reinforcement by pulling it back from the infilled fascia wall sections. Pin the back edge of the reinforcement layer so that it is taut and free from loose folds.
- D. Tracked equipment should operate over the reinforced backfill zone only after a minimum 152 mm (6 in) of backfill material have been placed over each

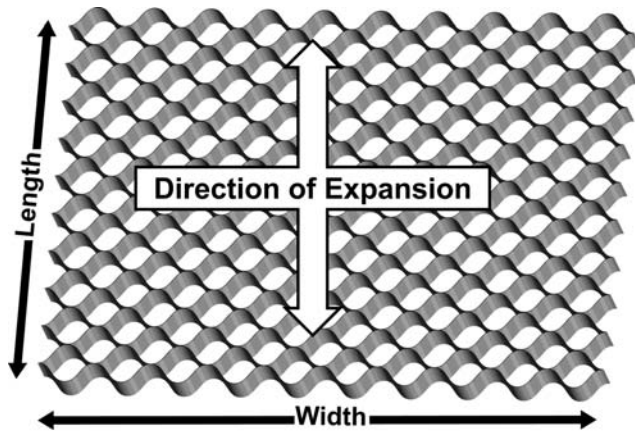
reinforcement layer. With permission of the project engineer, rubber tired equipment can operate directly on the reinforcement using care to avoid sudden stops and sharp turns.

- E. Place backfill over the reinforcement in compacted lifts of 152 mm (6 in) starting from behind the Cellular Confinement System wall fascia sections and spreading the backfill toward the back of reinforced zone. Ensure that excessive displacement of the reinforcement does not occur during backfill placement.
- F. Shape and compact the backfill material to a minimum 90% Modified Proctor Dry Density (ASTM D-1557). Heavy compaction equipment can be used to compact backfill materials to within 0.9 m (3 ft) of the Cellular Confinement System wall fascia section. As stated above, use lighter walk-behind compaction equipment to compact backfill materials directly behind the wall sections. Outward lateral displacement of the wall fascia section is an indication that excessive compaction is occurring. Continue process as developed above until wall is complete.

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### 3.07 WALL SECTION TABLE



Cellular Confinement System section length and width shall be as indicated in Figure 1. Sections shall have expanded dimensions per Table 1.

Note: All measurements are subject to manufacturing tolerances unless otherwise noted.

**Table 1 Section Dimensions**

Cells	Expanded Edge Length	Width Same for All Sections
3	2.63 ft	8.67 ft
4	3.50 ft	
5	4.38 ft	
6	5.25 ft	
7	6.13 ft	
Face Area for All Sections = 4.33 ft <sup>2</sup> (0.40m <sup>2</sup> )		

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### Appendix A

#### Short-Term Seam Strength Test Procedure



#### Frequency of Test

The short-term seam peel strength test (referred to as the 'test' in this section) shall be performed on a geocell section randomly taken directly from the production line each two hours.

#### Test Sample Preparation

Randomly choose 10 welds within the selected section and cut those welds from the section such that 10 cm (4 in) of material exist on each side of the weld. The test sample shall have a general appearance as illustrated in Figure A1. Prior to testing, the test samples shall have air cool for a minimum of 30 minutes from the time the selected geocell section was manufactured.

#### Short-term Seam Peel Strength Test

The apparatus used for testing the short-term seam peel strength shall be of such configuration that the jaws of the clamp shall not over stress the sample during the test period. Load shall be applied at a rate of 300 mm (12 in) per minute and be applied for adequate time to determine the maximum load. The date, time and load shall be recorded.

**Short-term seam peel strength shall be defined as the maximum load applied to the test sample. Minimum required short-term seam peel strength shall be:**

- 2840 N (640 lbf) for the 200 mm (8 in) depth cell
- 2130 N (480 lbf) for the 150 mm (6 in) depth cell

- 1420 N (320 lbf) for the 100 mm (4 in) depth cell
- 1060 N (240 lbf) for the 75 mm (3 in) depth cell

#### Definition of Pass / Failure

Two methods shall be used to determine acceptability of the manufactured geocell sections. The successful passing of the short-term seam peel test shall not be used to determine acceptable of the polyethylene for use in manufacturing of the geocell sections. Acceptability of the polyethylene shall be determined through tests conducted in Appendix B.

#### The Tested Value

If more than one of the tested seam samples fails to meet the minimum peel strength, all sections manufactured after the previously successful test shall be rejected.

If all tested seam samples meet the minimum peel strength, all geocell sections manufactured since the last successful test shall be considered to have passed the test.

When one of the tested seam samples fails to meet the minimum peel strength, another 10 samples shall be randomly selected and cut from the previously selected section. If more than one of these samples fails, all sections manufactured after the previously successful test shall be rejected. Otherwise, all geocell sections manufactured since the last successful test shall be considered to have passed the test.

#### Visual Failure Mode

After each sample is tested, the seam shall be examined to determine the failure mode. Two failure modes are possible.

- Material failure within and adjacent to the weld indicated by material strain and
- Weld failure resulting in complete separation of the seam and shows little or no material strain.

Upon examination, when the failure mode results in complete separation of the seam and indicates little or no material strain, product manufactured shall be rejected.