NORTHGATE LINK EXTENSION

RTA/LR 0177-09

LINK CONTRACT N180

TRACKWORK FROM UW STATION TO NORTHGATE STATION

(FLOATING SLAB ONLY)

CONTRACT SPECIFICATIONS

90 PERCENT

SEPTEMBER 2012

PREPARED BY:
PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes Specifications for designing, testing and furnishing of approved elastomeric support pads, side pads with bonded steel brackets, separation pads, and accessories for the resiliently supported discontinuous "double-tie" floating track slabs designed for 5Hz nominal resonance frequency and transition slabs designed for 7Hz and higher nominal resonance frequency under vehicle load.

B. Related Sections: The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of this work.

1. Section 03 05 15, Portland Cement Concrete.
2. Section 03 20 00, Concrete Reinforcing.
3. Section 03 41 00, Precast Structural Concrete.
4. Section 05 05 23, Painting of Brackets

C. The Following Operation Conditions:

D. 100 year life expectancy
E. 100,000,000 cycle fatigue life
F. Nominal static strain: 7 percent
G. Nominal static plus dynamic strain: 15 percent

1.02 STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents.

1. ASTM International (ASTM)
   a. ASTM A709 Standard Specification for Structural Steel for Bridges
   b. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
   c. ASTM D395 Standard Test Method for Rubber Property – Compression Set
   d. ASTM D412 Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers – Tension
   e. ASTM D429 Standard Test Method for Rubber Property – Adhesion to Rigid Substrates
   f. ASTM D471 Test Method for Rubber Property – Effect of Liquids
2. International Standards Organization (ISO)
   b. ISO289-2 Rubber, Unvulcanized – Determinations Using a Shearing-Disc Viscometer – Part 2: Determination of Pre-vulcanization Characteristics
   c. ISO 8013:2006(E) Rubber, Vulcanized - Determination of Creep in Compression or Shear
   d. ISO 3417 Rubber – Measurement of Vulcanization Characteristics with the Oscillating Disc Curemeter

1.03 DEFINITIONS

A. Elastomer: As used in this Specification, the word “elastomer” or “elastomeric” means “rubber”. The words are interchangeable.

1.04 SUBMITTALS

A. Samples: After testing samples in accordance with the requirements specified, submit the tested samples in quantities specified.

B. Shop Drawings: Show the details of support pads, side pads, separation pads and chemical composition of the elastomer compound.

C. Certificates:
   1. Submit certificates describing the chemical composition of all pads, method and place of manufacture, and batch number to verify that the products submitted for approval are as specified. Proprietary information will be considered confidential.
   2. Require the testing laboratory to simultaneously submit certified tests to the Resident Engineer or its designee and to the elastomer pad manufacturer within 7 Days after completion of specified tests.
   3. For materials and quality control procedures approved on prior contracts, submit certificates verifying that products meet specified requirements and are as previously tested and approved.
D. Documentation: Submit proposed production quality control program and obtain approval prior to any production.

1.05 QUALITY ASSURANCE

A. Qualification of Elastomer Manufacturer:

1. Regularly engaged in the manufacture of similar solid rubber items for a period of at least 5 years prior to Contract date.

B. Testing Laboratory:

1. Qualification Tests and Production Quality Control Tests shall be performed by an independent testing laboratory or independently monitored in-house laboratory. Employment of an independent laboratory does not relieve the Contractor of his obligation to perform the Work in accordance with requirements of the Contract Specifications and Contract Drawings.

2. Location. Testing shall be conducted within the continental United States of America.

3. Selection of Testing Laboratory: Subject to approval by the Resident Engineer.

C. Qualification Testing: Prior to commencing production of elastomer support pads, side pads, and separation pads, produce and test production prototype or initial production elastomer pads for compliance with physical and mechanical requirements as specified.

1. Test both materials and fabricated products.

2. Permanently identify each qualification test sample pad by an approved identification code showing the name of the manufacturer, batch and lot number, date of manufacture, and any pertinent information to relate the samples to test reports.

3. The Resident Engineer or its designee may monitor and inspect production of qualification test elastomeric materials, sample selection, and testing.

4. Notify the Resident Engineer or its designee at least 14 Days in advance of scheduled qualification tests.

5. Produce two sample support pads of each Type, two sample side pads, and two sample separation pads as prototypes or initial production units for mechanical property tests, and sufficient additional elastomer pads or material samples from the same compound batch to perform each material physical property test on two samples.

6. Perform testing in accordance the testing procedures and requirements specified in Article 1.05D and 1.05E, herein.

7. After completion of qualification tests, provide Resident Engineer with sample isolation pads as specified in Article 1.04A, herein.

8. Do not commence production until receipt of approval of the qualification test results in writing from the Resident Engineer. Should any qualification test fail, remanufacture and test new samples at no additional cost to Sound Transit.

D. Production Quality Control: Develop, implement and maintain a program of production quality control for elastomeric materials and manufacturing procedures to ensure that all supplied pads comply with specified requirements for physical and mechanical properties. The following are program requirements:
1. Submit six copies of detailed description of the proposed Production Quality Control Program.

2. Permanently identify each selected support, side, and separation pad sample by an approved identification code showing the name of manufacturer, batch and lot number, date manufactured, and any pertinent information to relate the samples to test reports.

3. The Resident Engineer or its designee may monitor and inspect production of elastomeric materials, sample selections and testing.

4. Notify the Resident Engineer or its designee at least 14 Days in advance of scheduled production quality control tests.

5. Test production materials and pads per Table 1 to demonstrate compliance with requirements specified in Article 1.05E.

6. Commence the Production Quality Control tests no later than 30 Days after the isolation pad lots or batches are fabricated. Should any of the random samples selected fail to meet the requirements of the required tests, the Resident Engineer has the option of testing or rejecting the remainder of the production lot under consideration.

7. After completion of Quality Control Testing, supply Resident Engineer with one sample from each production pad lot tested.

8. Conduct all production testing within United States of America.

<table>
<thead>
<tr>
<th>Article</th>
<th>Test Type</th>
<th>Minimum Frequency of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.05E.1</td>
<td>Rheological Properties</td>
<td>Every Batch</td>
</tr>
<tr>
<td>1.05E.1</td>
<td>Mooney Viscosity</td>
<td>Every Batch</td>
</tr>
<tr>
<td>1.05E.1</td>
<td>Mooney Scorch</td>
<td>Every Batch</td>
</tr>
<tr>
<td>1.05E.2</td>
<td>Tensile Test</td>
<td>1 per 5 Batches</td>
</tr>
<tr>
<td>1.05E.2</td>
<td>Aging properties</td>
<td>1 per 5 Batches</td>
</tr>
<tr>
<td>1.05E.2</td>
<td>Weather Resistance</td>
<td>1 per 5 Batches</td>
</tr>
<tr>
<td>1.05E.3</td>
<td>Flame and Smoke Generation</td>
<td>1 per 5 Batches</td>
</tr>
<tr>
<td>1.05E.4</td>
<td>Static Load vs Deflection</td>
<td>One of Every 20 Type I Main Pads</td>
</tr>
<tr>
<td>1.05E.4</td>
<td>Dynamic Stiffness Test</td>
<td>One of Every 20 Type I Main Pads</td>
</tr>
<tr>
<td>1.05E.4</td>
<td>Long Term Creep</td>
<td>One of Every 20 Type I Main Pads</td>
</tr>
<tr>
<td>2.02B.7</td>
<td>Bond to Steel</td>
<td>One in every 20 Side pads</td>
</tr>
<tr>
<td>2.01E</td>
<td>Hardness</td>
<td>One in every 20 Type I Pads</td>
</tr>
</tbody>
</table>
E. Testing Procedures and Requirements:

1. Raw Material Tests: Complete the following tests before vulcanization to establish consistency of raw, unvulcanized rubber:

   a. Rheological properties per ISO 3417
   b. Mooney viscosity per ISO 289-1
   c. Mooney scorch per ISO 289-2

2. Elastomeric Material Physical Property Tests: Determine the properties of the elastomer pad material by performing the following tests on specimens taken from complete pads. In the event test specimens cannot be taken from finished pads, for these tests use samples certified to have been taken from the same batch of compound used for making the elastomer pads and having an equivalent cure. Prior to the testing, condition all elastomer samples for not less than 2 Days at 22 +/- 3 degrees C and at 50 percent relative humidity.

   TABLE 2. ASTM TESTS

<table>
<thead>
<tr>
<th>Test</th>
<th>Conditions</th>
<th>Properties</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tensile strength</td>
<td></td>
</tr>
<tr>
<td>ASTM D412</td>
<td>Un-aged</td>
<td>Tensile strength</td>
<td>3044 psi min.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ultimate elongation</td>
<td>500 percent min.</td>
</tr>
<tr>
<td>Aging Properties</td>
<td></td>
<td>Compression set</td>
<td>30 percent max.</td>
</tr>
<tr>
<td>ASTM D395</td>
<td>24 hours at 100 degrees C</td>
<td>Change in tensile strength</td>
<td>15 percent max.</td>
</tr>
<tr>
<td>Method B</td>
<td></td>
<td>Change in hardness</td>
<td>5 IRHD max.</td>
</tr>
<tr>
<td>ASTM D573</td>
<td>70 hours at 100 degrees C</td>
<td>Change in ultimate</td>
<td>20 percent max.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>elongation</td>
<td></td>
</tr>
<tr>
<td>Weather Resistance:</td>
<td></td>
<td>Ozone resistance</td>
<td>No cracks apparent to the unaided eye after 168 hours</td>
</tr>
<tr>
<td>ASTM D1149</td>
<td>200 pphm ozone for 168 hours at 40 degrees C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume change</td>
<td>20 percent max.</td>
</tr>
<tr>
<td>ASTM D471</td>
<td>70 hours at 100 degrees C (212 degrees F) in distilled water</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight increase</td>
<td>10 percent max.</td>
</tr>
</tbody>
</table>

3. Flame Spread and Smoke Generation Test

   a. Test Method: Test the elastomer in accordance with the ASTM E162 to determine the flame propagation index. Test the elastomer in accordance with ASTM E662 in both the flaming and non-flaming modes to determine the smoke generation specific optical index.
b. Acceptance Criteria: No evidence of flaming drippings when tested. No acceptance criteria are specified for the flame propagation index or the smoke generation specific optical index. Report these indices to the Resident Engineer or its designee for information only.

4. Elastomer Pad Mechanical Property Tests: Subject two Type I specimen main support pads for 5Hz floating slab, two Type II specimen transition support pads, two Type III specimen transition support pads, two Type IV specimen transition support pads, and two specimen side pads, either taken from a production run or fabricated as prototypes from a batch of compound certified by pad manufacturer to be a batch containing elastomer as used for a production run and fabricated with cure equivalent to a production run, to static and dynamic load tests as follows:

a. Test in spaces having ambient temperature of 22 +/- 3 degrees C. Temperature of specimens to be stabilized in that temperature range for not less than 4 hours except as noted.

b. Main Support Pad Static Stiffness Tests:

1) Procedure: Precondition each main support pad by loading from zero to maximum load of 10,000 pounds and back to zero for three complete cycles before beginning each static load test. Apply a compression load increasing continuously or in increments of 500 pounds to maximum load of 10,000 pounds at a rate not exceeding 500 pounds/min. After reaching 10,000 pounds load, decrease the load at a rate of 500 lbs per minute until zero load is reached. Apply load to the center of the top and bottom loading plates arranged to uniformly load the support pad. Equip loading plates with friction surfaces to prevent slippage of rubber at loaded face. Apply load and plot the load-deflection curve continuously by machine for two complete load cycles or, for each 500 pound load increment, measure the deflection under compression of the pad to an accuracy of 0.001 inch or better and record. Loading plates shall be steel of uniform thickness at least 1 inch.

2) Stability: Main support pad shall not exhibit any sign of instability for loads up to maximum load during preconditioning.

3) Static Stiffness: Plot the static load test results on a graph to indicate the compression load vs deflection for at least two complete loading and unloading sequences. Determine the static load stiffness from the slopes (Ktan) of the load-deflection curve for loads in the range specified in Article 2.01F for main support pads. Use 2nd-order or higher polynomial regression of the load vs. deflection curve separately for loading and unloading portions of each cycle. Determine the slopes of the load vs. deflection curves at each load increment and decrement by calculating the respective derivatives of the regression curves. Static stiffness shall be within the range specified for each type of main support pad for both loading and unloading portions of the curve.

c. Side Pad Static Stiffness Tests:

1) Procedure: Precondition each pad by loading from zero to maximum load of 7,000 pounds and back to zero for three
complete cycles before beginning each static load test. Apply a compression load increasing continuously or in increments of 500 pounds to maximum load of 7,000 pounds at a rate not exceeding 500 pound/min. After reaching 7,000 pounds load, decrease the load at a rate of 500 lbs per minute until zero load is reached. Load to be applied to the center of a loading plate arranged to uniformly load the side pad in compression. Apply load and plot the load-deflection curve continuously by machine for two complete load cycles or, for each 500 pound load increment, measure the compression of the pad to an accuracy of at least 0.001 inch or better and record.

2) Static Stiffness: Plot the static load test results on a graph to indicate the compression load vs deflection for at least two complete loading and unloading sequences. Determine the static load stiffness from the slope (Ktan) of the load-deflection curve for loads specified in Article 2.01F, herein, for side pads. Use 2nd-order or higher polynomial regression of the load vs. deflection curve separately for loading and unloading portions of each cycle. Determine the slopes of the load vs. deflection curves at each load increment and decrement by calculating the respective derivatives of the regression curves. Static tangent stiffness: within the range given in Article 2.01F.5, herein, for side pads for both loading and unloading portions of the curve.

d. Ratio Dynamic-to-Static Stiffness Test: Perform tests on each of the complete main support pads tested for static stiffness by using either a mass loading or an applied dynamic force procedure.

1) Mass loading procedure: Load each of the sample main support pads in compression with a mass weighing 5,900 pounds. Load each of the sample side pads in compression, load normal to bonded plates, with a mass of 2,400 pounds. Impart a vertical impulsive compressive load normal to the bonded plates to the center of the loading plate, block, or fixture. Support pads on a surface with stiffness exceeding 500,000 pounds/inch. Rotate side pads 90° from normal orientation for this test so that the face with maximum surface area is horizontal. Determine the amplitude and frequency of vertical movement of the load mass in response to the impact by the use of an accelerometer and oscilloscope, strip chart recorder or FFT analyzer. Determine the frequency of the fundamental or lowest vertical oscillation frequency by counting the sinusoidal zero-crossings for a given time interval. With this procedure, determine the dynamic spring rate, K_{dyn}:

\[ K_{dyn} = 39.5 \times \frac{W}{g} \times f_n^2 \]

where

- \( K_{dyn} \) = dynamic spring rate, pounds/inch
- \( f_n \) = observed natural frequency, Hz.
- \( W \) = weight of loading mass, pounds.
- \( g \) = Acceleration of gravity, 386 inches/sec\(^2\)
2) Dynamic force procedure: Preload the elastomer pad with a static compression load as specified in 2.01G. Then, under the static compressive preload, apply a superimposed dynamic load sufficient to deflect the pad by 0.1 inch peak-to-peak dynamic amplitude (0.05 inch relative to preload compression) at a frequency of 10Hz. The dynamic stiffness is the measured peak dynamic force divided by the measured peak dynamic deflection. Verify that combined mass of the loading plate and fixture between the load cell and pad is less than 60 pounds. If this procedure is used, conduct the static load test immediately after the dynamic stiffness test with the elastomer at the same internal temperature for both tests.

3) Verify that the ratio of dynamic stiffness determined by these tests to the static stiffness determined by the static load test does not exceed the ratio of dynamic-to-static stiffness as specified in Article 2.01G, herein. The static stiffness shall be computed as the slope of the load vs. deflection curve at the static load used for the dynamic test. Use the average of the static stiffness obtained during loading and unloading portions of the load versus deflection curve obtained in Article 1.05E.4.b for the main support pads and Article 1.05E.4.c for the side pads.

e. Long Term Creep Test: Perform a long term creep test on three main support pads as part of the qualification tests and one pad of each production run.

1) Mechanical Conditioning: Strain the pad in compression by about 25 percent at a rate of 1 inch/min in the same direction as in the test and then return it to approximately zero deflection. Repeat this pre-compression conditioning step for a total of five deformations. Allow a total of not less than 16 hours and not more than 48 hours at standard laboratory temperature to elapse between mechanical conditioning and testing. Ensure stability of the pad under compression.

2) Test: Apply a constant compressive load to the main support pad of magnitude equal to the median of the static stiffness test load range using steel loading plates of sufficient thickness to ensure uniform deflection of the loaded surfaces of the pad to within 5 percent of the mean deflection. Roughen the load surfaces of the steel plates or adhere the rubber pads to the steel plates to ensure that no lateral slip occurs between the loaded surface of the pad and the steel plate. Bring the applied load up to the maximum test load within a time period of less than 6 seconds measured from the beginning of the application of load. Maintain the load for 14 Days. Measure deflections in inches with a precision of at least 0.0001 inch at one minute after load application and then at intervals of decades of minutes up to ten thousand minutes (10, 100, 1000, and 10,000 minutes) and at the end of the 14-Day period. Plot the deflection versus the logarithm base ten (LOG 10) of the time in minutes on semi-log scales. Perform a linear regression analysis of the deflection, X, in inches versus the common logarithm of time in minutes, T, from the beginning of the load application, using the following formula:

\[ X = A \text{ (inches/decade time)} \times \text{Log}_{10} (T \text{ (minutes)}) + X_1 \text{ (inches)} \]
4) Calculate the Creep Index Rate as the regression coefficient, A (inches/decade time), divided by the regression coefficient, X₁ (inches). X₁ is the regression coefficient representing the deflection in inches at 1 minute after application of load.

5) Criterion: The Creep Index Rate: less than 0.015 times the initial deflection at one minute per decade time. (1.5 percent of the initial deflection at one minute per decade time.)

6) If one or more of the three qualification main support pads fail the creep test, the pads shall be deemed to have failed the qualification test. Calculate the mean creep rate of the three test pads. If an individual result differs from the mean by more than 10 percent, test three additional pads and report the results for all pads. If the production main support pad fails the creep test, test two additional pads of the same production run. If either or both of the two additional production run pads fail, the entire production run shall be rejected.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver all materials to the job site bearing waterproof labels identifying the material and giving its size, designation, and type. Store products in a dry area and protect from contact with soil and from exposure to the elements. Keep products dry and damage-free.

PART 2 - PRODUCTS

2.01 ELASTOMER PADS

A. General: High grade natural rubber as specified with reinforcing agents, antioxidants, anti-ozonants, and anti-ozonant paint to provide isolators with resistance to long term creep as specified herein, and with specified physical and aging properties. Vulcanize compound in manner to give stable dynamic properties and specified mechanical properties. The elastomer of all pads shall be of the same formulation and nominal durometer.

B. Dimensions:

1. Type I Support Pads (Refer to contract drawings):
   a. Outer diameter: 12.5 inches
   b. Unloaded Thickness: 7.5 inches

2. Type II Support Pads (Refer to contract drawings):
   a. Rubber Diameter: 12.5 inches
   b. Layers: 2
   c. Overall Thickness: 7.5 inches
   d. End-Plate Thickness: 0.1875 inch
   e. Intermediate Plate Thickness: 0.1875 inches
   f. Thickness of rubber at top and bottom: 0.28125 inch
g. Minimum rubber thickness between plate edge and lateral surface: 0.375 inch

3. Type III Support Pads (Refer to contract drawings)
   a. Rubber Diameter: 12.5 inches
   b. Layers: 3
   c. Overall Thickness: 7.5 inches
   d. End-Plate Thickness: 0.1875 inch
   e. Intermediate Plate Thickness: 0.1875 inch
   f. Thickness of rubber at top and bottom: 0.28125 inch
   g. Minimum rubber thickness between plate edge and lateral surface: 0.375 inch

4. Type IV Main Support Pads (Refer to contract drawings)
   a. Rubber Diameter: 12.5
   b. Layers: 4
   c. Overall Thickness: 7.5
   d. End-Plate Thickness: 0.1875 inch
   e. Intermediate Plate Thickness: 0.1875 inch
   f. Thickness of rubber at top and bottom: 0.28125 inch
   g. Minimum rubber thickness between plate edge and lateral surface: 0.375 inch

5. Side Pads (Refer to contract drawings):
   a. Rectangular Elastomer block 7 inches high by 18 inches wide by 4 inches thick.
   b. Vulcanize bonded to metal parts as shown on Contract Drawings.
   c. Provide 1/2 inch concave edge radius in elastomer at edge of bond between elastomer and plate.

6. Separation Pads (Refer to contract drawings):
   a. Rectangular Elastomer block 5 inches high by 6 inches wide by 2.875 inches thick.

C. Dimensional Tolerances:
   1. Diameter or length and width: Within 0.1 inch
   2. Thickness: Within 0.1 inch
   3. Squareness: 90 +/-2 degrees
   4. Surfaces: Smooth, with no bubbles or voids.
D. Formulation of Elastomer used for Manufacture of Pads:

1. Compound elastomer pads using the formulation given in the following schedule, and mix and cure to give physical and mechanical properties specified:

<table>
<thead>
<tr>
<th>Component</th>
<th>Parts by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPNR, RSS1 or better natural rubber stock</td>
<td>100</td>
</tr>
<tr>
<td>Zinc Oxide</td>
<td>5</td>
</tr>
<tr>
<td>Antiozonant (a)</td>
<td>3</td>
</tr>
<tr>
<td>Zinc 2-ethyl-hexanoate</td>
<td>1</td>
</tr>
<tr>
<td>SRF Black</td>
<td>20</td>
</tr>
<tr>
<td>MOR (b)</td>
<td>1.2</td>
</tr>
<tr>
<td>TBTD (c)</td>
<td>0.5</td>
</tr>
<tr>
<td>DPG</td>
<td>0.5</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.5</td>
</tr>
</tbody>
</table>

a. Santoflex 13 or equivalent
b. Santocure MOR, Amax or 2 (Morpholimothia) Benzothiazole or equivalent
c. Butyl Tuads

2. Mix for sufficient time to incorporate rubber in voids and maximize disbursement of SRF Black filler

3. Mooney at 120 degrees C, \( V_{0.5} \): 39

4. Scorch time at 120 degrees C: 30 minutes

5. Rheometer at 140 degrees C
   a. \( t_{90} \): 15 minutes
   b. \( t_{95} \): 20 minutes

E. Hardness: 42 +/- 5 durometer hardness; Shore A in accordance with ASTM D2240.

F. Static Stiffness (Tangent to the Load vs Deflection Curve) of Elastomer Pads:

1. Type I Main Support Pads: 5,700 pounds/inch +/-10 percent for compressive loads in range of 2,800 to 6,000 pounds.

2. Type II Main Support Pads: 9,400 pounds per inch +/- 15 percent for compressive loads in the range of 2,800 and 6,200 pounds

3. Type III Main Support Pads: 15,400 pounds per inch +/- 20 percent for compressive loads in the range of 2,800 and 6,400 pounds

4. Type IV Main Support Pads: 23,800 pounds per inch +/- 25 percent for compressive load in the range of 2,500 and 6,500 pounds
5. Side Pads: 11,900 pounds per inch +/- 20 percent for compressive loads between 1,000 and 3,000 pounds

6. Separation Pads: 3,200 pounds per inch +/- 20 percent for compressive loads in range of 1,000 to 1,500 pounds.

G. Ratio of Dynamic-to-Static Stiffness:

1. The dynamic-to-static stiffness of the elastomer support pads and side pads: Do not exceed the limits below when computed in accordance with the following equation.

\[ \text{Dynamic-to-static stiffness ratio} = \frac{K_{\text{dyn}}}{K_{\text{tan}}} \]

Where:

- \( K_{\text{dyn}} \) = Dynamic stiffness of a support pad in compression at specified static load, determined according to the procedures specified in Article 1.05E.4.
- \( K_{\text{tan}} \) = Static tangent stiffness of a pad in compression at static load used for dynamic test, as determined by the procedures specified in Article 1.05E.4.

2. Required static preloads during determination of the dynamic stiffness:
   a. Type I, II, III, and IV main support pads: 5,900 pounds
   b. Side pads: 2,400 pounds

3. Dynamic-to-static Stiffness Ratios
   a. Type I Main Support Pad: 1.3
   b. Type II Main Support Pad: 1.4
   c. Type III Main Support Pad: 1.4
   d. Type IV Main Support Pad: 1.5
   e. Side Pad: 1.4

H. Creep Test

1. Acceptable creep rate: less than 1.5 percent per decade time of the initial deflection measured at 1 minute after load.

I. Adhesion to Metal or Concrete:

1. During the manufacture of the elastomer pads, use ingredients of types which will not preclude the cementing of pads to concrete and metals.

J. Form Release Agents: Of a type which will neither preclude the cementing of pads to concrete and metals, nor physically and chemically affect the elastomeric materials.

K. Adhesive for Cementing Pads to Concrete and Metals:

1. Recommended by the pad manufacturer,
2. Neither physically nor chemically affect the elastomeric materials and metal parts.

L. Anti-Ozonant Paint; The exterior unloaded surfaces of each pad shall be treated with a coating of anti-ozonant paint.
M. Acceptable product: Lord Corporation HPC-5C Coating (no known equal)

N. Minimum Thickness: 0.001 inch

O. Follow manufacturer's specifications for application.

P. Treat natural rubber surfaces with Lord Corporation Chemlok 7701, as specified by manufacturer. Do not let Chemlock 7701 contact metal surfaces of side pads.

2.02 METALS

A. Inner Steel Laminate Plates for Type II, Type III, and Type IV Main Pads
   1. Thickness 3/16 inch
   2. ASTM A709 Grade 36 Steel
   3. Edges and corners rounded to radius not less than 3/32 inch

B. Side Pad Structural Steel Angles and Plates:
   1. Structural parts of cold rolled steel as shown on the Contract Drawings with dimensional tolerance of 1/16 inch.
   2. Structural steel for vulcanized bonded side pad assemblies:
   3. Conform to ASTM 572 – minimum yield stress 50,000 psi.
   4. Treat welded assembled steel parts by acid dip before vulcanizing for eventual application of epoxy armoured base and finish paint
   5. Apply epoxy armoured base and finish paint to exposed steel surfaces after vulcanizing.
   6. Epoxy color: Yellow
   7. Bonding Side Pad Elastomer to Steel Plates or Angles:
      a. Bond elastomer material to structural steel during vulcanization in a compression mold using appropriate procedure and bonding agent. Sharp corners to be eliminated from rubber by radius at peripheral junction with steel parts.
      b. Cleaning and preparation of steel, bonding procedure and materials to produce bond of quality to give a type R failure when tested for tear strength. (Rubber fails before bond fails.)
      c. Test bonding of side pad elastomer to steel for two sample side pads in accordance with ASTM D429 (Method B). Acceptable failure: type R failure, i.e., elastomer tears before bond fails.

C. Side Pad Design Requirements

D. Side pads shall withstand horizontal loads of at least 10,000 pounds without slippage, yielding, or fracture for all positions of adjustment.

E. Side pads shall withstand vertical loads applied at the outer (unisolated) plate of at least 8,000 pounds without slippage, yielding, or fracture.
F. Side pads shall withstand 100,000,000 cycles of vertical repeated deflections of floating slab of 0.5 inch downward and 0.5 inch upward without slippage, yielding, or fracture for all positions of adjustment.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ensure that anti-ozonant coating is not damaged prior to or during shipping. Pads with damaged anti-ozonant coatings shall be discarded.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Description

1. The Work specified in this Section consists of requirements for precast fabrication of two types of floating slabs; Standard and Special Slice Trench Type, furnishing precast concrete tunnel floating slabs to support trackwork sections as indicated on the Contract Plans, including reinforcing bars; anchor inserts for direct fixation fasteners; anchor inserts for side mounted brackets and anchor inserts and eye bolts for lifting both types of floating slabs; In addition installation bolts for anchor inserts for trench cap assembly.

2. The Work includes procurement of anchor inserts as shown on the Contract Plans and presetting their location accurately to the tolerances stated within the floating slab.

3. The Work includes the handling, receiving and storing of rubber support pads for application to the floating slabs.

4. The Work includes the bonding (gluing) of the floating slab rubber support pads to the underside of the floating slabs in the designed recessed pockets.

5. The Work includes the rubber support pads and appropriate rubber adhesive (Contractor Furnished) be shipped directly to the floating slab fabrication site from the manufacturer of the rubber pads for application to the slabs.

6. The Work includes all ancillary activities as may be required to complete an acceptable floating slab product.

B. Section Includes:

1. Floating Slab Formwork
2. Concrete Reinforcement
3. Precast Concrete
4. Floating Slab Anchor Inserts
5. Elastomer Component Requirements per Section 13 48 11.
6. Tolerances
7. Shop Quality Control
8. Handling, Delivery and Stockpiling
C. Related Sections

1. Section 01 11 00, Summary of Work
2. Section 01 33 00, Submittal Procedures
3. Section 01 45 00, Quality Assurance /Quality Control
4. Section 01 66 00, Product Storage and Handling Requirements
5. Section 03 05 15, Portland Cement Concrete
6. Section 03 11 00, Concrete Forming
7. Section 03 15 00, Concrete Accessories
8. Section 03 20 00, Concrete Reinforcing
9. Section 03 30 00, Cast-In-Place Concrete
10. Section 03 35 00, Concrete Finishing
11. Section 05 05 23 Metal Fastenings
12. Section 13 48 11, Elastomer Isolation pads

1.02 REFERENCES

A. American Concrete Institute (ACI)
   1. ACI 301 – Specifications for Structural Concrete
   2. ACI 347 Guide to Formwork for Concrete Structures
   3. ACI 517.2 Accelerated Curing of Concrete at Atmospheric Pressure

B. American National Standards Institute (ANSI) and American Society of Mechanical Engineers (ASME) joint standards
   1. ASME/ANSI B1.1 - Unified Inch Screw Threads, (UN and UNR Thread Form)

C. ASTM International (ASTM):
   1. ASTM A449 Standard Specification for Hexagon Cap Screws Bolts and Studs, Steel, heat Treated 120/105/90ksi; minimum Tensile Strength general Use
   2. ASTM A536 Standard Specification for Ductile Iron Castings
   3. ASTM C31/C31M Standard Practice for Making and Curing Concrete Test Specimens in the Field
4. ASTM C33    Standard Specification for Concrete Aggregates
6. ASTM C78    Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
7. ASTM C109    Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
11. ASTM C204   Standard Test Methods for Fineness of Hydraulic Cement by Air Permeability Apparatus
12. ASTM C172   Standard Practice for Sampling Freshly Mixed Concrete
14. ASTM C231   Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
15. ASTM C430   Standard Test Method for Fineness of Hydraulic Cement by the 45-µm (No. 325) Sieve
17. ASTM C494/C494M   Standard Specification for Chemical Admixtures for Concrete
18. ASTM C586   Standard Test Method for Potential Alkali Reactivity of Carbonate Rocks as Concrete Aggregates (Rock-Cylinder Method)
19. ASTM C856   Standard Practice for Petrographic Examination of Hardened Concrete
20. ASTM C1105  Standard Test Method for Length Change of Concrete Due to Alkali-Carbonate Rock Reaction
22. ASTM C1293  Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction

D. Society of Automotive Engineers (SAE):
1. SAE J429 Mechanical and Material Requirements for External Threaded Fasteners

1.03 REQUIREMENTS

A. Produce floating slabs and formwork/molds in accordance with the Contract Plans to achieve and maintain specified tolerance and finish. Floating slabs that do not conform to dimensional tolerance or specified finish will be rejected.

B. Produce floating slab formwork to ensure floating slab embedded anchor inserts conform to the tolerance shown on the Contract Plans.

C. Produce two initial floating slabs of each size (3'-10" and 7'-10") to be used as the confirmation of product for overall size, shape, surface finish and proper positioning of all anchor inserts as specified per Paragraph 3.06 - Slab Testing Procedures and requirements.

D. Underside support pads shall be bonded centrally within the recessed opening to the tolerances specified.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00, Submittal Procedures.

B. Product Data: Manufacturer's product data and performance sheets, including recommendations and requirements for handling, storage, and protection for the following:

C. Shop Drawings:

1. Dimensioned details of precast concrete geometries and features comprising:
   a.) Layout and size of each section.
   b.) Concrete grade and type.
   c.) Reinforcement.
   d.) Inserts and insert drilling location indicators.
   e.) Section identification information - including methods and parking scheme for slabs and slabs with special support rubber base pads marked IV, III, or II.

2. Details for construction of each type of mold used to cast the precast concrete sections. Include for each type of section:
   a.) The number of molds to be fabricated.
   b.) Details for securing embedded items in place during casting.
   c.) Form geometry and dimensions.
   d.) Fabrication Tolerance for:
1.) Length

2.) Width

3.) Flatness of joint face

4.) Insert locations

D. Working Drawings and Method Statements:

1. Physical description and properties of design elements, including details, dimensions.

2. Details of production, comprising:
   a.) Name, address, and contact information for the Floating Slab Manufacturer.
   b.) Location of casting and storage yards.
   c.) Means and methods for:
      1.) Batching concrete.
      2.) Casting, curing, and stripping/demolding segments.
      3.) Handling and storing segments.
   d.) Production schedule.

E. Mix Designs: In accordance with Section 03 05 15, Portland Cement Concrete, and as specified herein.

F. Qualifications:

1. Floating Slab Manufacturer.

2. Floating Slab Designer.

3. Certified Testing Laboratory.

G. Certifications:


2. That precast concrete sections meets minimum design and performance criteria specified.

3. Separately by Contractor and manufacturer that precast concrete sections are capable of supporting storage, transportation, handling, and erection loads.

4. By Contractor that the tolerance specified is consistent with the Contractor’s proposed configuration and geometry.
H. Sample:

1. After testing samples in accordance with the requirements specified, submit the test results and retain samples for comparison purposes.

2. Provide qualification samples (3 each) of the following:
   a.) Ductile iron anchor inserts for Types I and II
   b.) Lifting eye bolts
   c.) Anchor insert threaded closure plugs for open inserts
   d.) Side bracket shim
   e.) Survey plaques and adhesive for mounting

I. Quality Control Plans:

1. Casting:
   a.) Methods for measuring and assuring that tolerances are met with due consideration for thermal, moisture, and ambient temperature influences.
   b.) Methods for testing and sampling to verify minimum required compressive strength before stripping, all in accordance with Section 03 05 15, Portland Cement Concrete.
   c.) Methods for demolding segments to prevent spalling and other forms of damage to segment edges.
   d.) Methods for controlling shrinkage and temperature cracking.
   e.) Methods for assuring even distribution of concrete mix during placement in molds.
   f.) Record keeping and procedures for resolving quality defects.

2. Slab Protection: Methods for protecting slab section and appurtenances from damage while handling, transporting, storing, and installing.

3. Mockups assuring compliance with indicated tolerances and interchangeability requirements.

J. Records:

1. Fabrication
   a.) Daily and weekly summaries of fabrication, including types of sections, mixes used, curing details, strength testing results, storage location, and other information specified herein.
   b.) Weekly summary of sections transported to the construction sites.
c.) Weekly summary of damaged sections at the fabrication plant, including types of repairs if used, and whether repairs were successful.

d.) Results of slab and mold dimension checks.

e.) Results of mock ups and insert positions.

f.) Source Quality Control testing results.

1.05

1. Samples: After testing samples in accordance with the requirements specified, submit the test results and retain samples for comparison purposes.

1.06 QUALITY ASSURANCE / QUALITY CONTROL

A. General: Refer to Section 01 45 00 - Quality Assurance/Quality Control for quality assurance and control requirements and procedures.

B. Testing Laboratory:

1. Qualification Tests and Production Quality Control Tests shall be performed by an independent testing laboratory or independently monitored in-house laboratory. Employment of an independent laboratory does not relieve the Contractor of his obligation to perform the Work in accordance with requirements of the Contract Specifications and Contract Drawings.

2. Location: Testing shall be conducted within the continental United States of America.

3. Selection of Testing Laboratory: Subject to approval by the Resident Engineer.

C. Production Quality Control - Develop, implement and maintain a program of production quality control for materials to ensure materials supplied satisfy specified requirements for compounding and physical and mechanical testing. Program requirements:

1. Include in program both compounds and mixing products.

2. Confirm permanently identified selected support pads for application to each special slab.

3. Sound Transit or its designee may monitor and inspect production of floating slabs, materials, sample selections and testing.

4. Notify Sound Transit or its designee at least 14 days in advance of scheduled production quality control tests.

1.07 DELIVERY, STORAGE AND HANDLING

A. General: refer to Section 01 66 00 – Product Storage and Handling Requirements: submit the method of handling, shipping, unloading, and placing into storage fabricated concrete floating slabs and accessories for review and acceptance at least 4 weeks before shipping the precast concrete floating slabs.
B. Shipping and Handling:

1. Hooks or shackles through lifting eye bolts installed in the appropriate threaded anchor inserts is the only approved method of handling floating slabs during transport.

2. Ship and handle the two types of precast concrete floating slabs as recommended by the manufacturer. Make certain that all handlers use only approved equipment for handling precast concrete floating slabs.

3. Ship the precast concrete floating slabs securely braced with wooden spacer blocks so that the top surface with lift eye bolts and the bottom surface or bonded rubber support pads do not contact floating slab loaded above and in a horizontal top side up position to prevent movement that could cause damage.

4. Do not drop or skid precast concrete floating slabs.

C. Load, deliver, unload, and place into storage precast concrete floating slabs. Store specially marked IV, III, II slabs separately for easy identification and access. Store slabs with sufficient dunnage size to allow attached support pads to be free of any load.

1.08 WARRANTY

A. Warranties shall be per Division 1 requirements.

B. In lieu of the standard warranty provided in the General Conditions, provide an unconditional warranty for replacement of defective precast concrete floating slabs for a period of 1 years from the date of final acceptance of all precast concrete floating slabs that incorporate the component design; or with the year of production, year “N,” as cast until December 31 of the year N plus 5, whichever occurs last.

1. If it should be necessary to retire these precast concrete floating slabs from service during the stated warranty period due to fracture or a defect, jointly inspect the failed floating slab in the presence of Sound Transit and provide all quality control records associated with production of the floating slabs.

2. If the inspection and examination establishes that the cause of the failure is attributable to a defect of fabrication, then replace the faulty precast concrete floating slabs at no cost to Sound Transit.

3.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Precast Concrete Floating Slab segments – Precast Structural Concrete with embedded inserts for direct fixation floating slab tunnel track as stated in these Specifications and with recessed surfaces and channels as shown on the Contract Plans.

2.02 CONCRETE

A. Portland Cement:
1. In accordance with Section 03 05 15 – Portland Cement Concrete provide cement conforming to ASTM C150, Type II, low alkali, and the following:

   a.) Provide cement with an alkali content of NA2O equivalent (Na2O + 0.658 K2O) as low as possible, but not greater than 0.6 percent.

   b.) Provide cement with a false set penetration, in accordance with ASTM C451 that is not less than 50 percent at final penetration.

2. Do not use more than two sources of clinker or ground cement during any 1 month.

   a.) Clearly identify cement from each source and store cement from each source in separate weather-tight silos.

   b.) If two sources of cement are used for fabrication perform the tests herein, on the first batch of concrete made using each source of cement, and thereafter as required herein.

      1.) Take separate random samples of cement each day to represent the cement used on each slab production.

      2.) Each sample may not be less than 1 gallon and must be clearly identified with the date and number of slabs.

      3.) Keep each sample in airtight containers until the corresponding 28-day cylinder tests have been carried out and results accepted by Sound Transit.

   c.) Conduct compressive strength tests as required herein, on concrete made with each type of cement.

   d.) Only use cement that has been pre-qualified through the tests listed in this Section.

   e.) Provide weekly cement mill certificates from each contractor and include the results of the following tests for cement delivered during that week:

      1.) Fineness by air permeability: In accordance with ASTM C204.

      2.) False Set: In accordance with ASTM C451.

      3.) Setting Time: In accordance with ASTM C191.

      4.) Compressive Strength: In accordance with ASTM C109 at 1 day, 3 days, and 7 days.

      5.) Chemical Analysis: In accordance with ASTM C114, including SiO2, Al2O3, Fe2O3, CaO, MgO, SO3, K2O, Na2O, and calculated alkalis as Na2O equivalent, C2S, C3S, C3A, C4AF.

      6.) Residue on 325-mesh sieve: In accordance with ASTM C430.

3. At least once during every 4 weeks use an independent testing laboratory to analyze a randomly chosen sample of cement from each source used for alkali content in accordance with ASTM C114.
4. Compressive Strength - Not less than 7000 psi at 28 days when tested in accordance with ASTM C39.

B. Concrete Aggregates:

1. In accordance with Section 03 05 15 Portland Cement Concrete, and provide both fine and coarse heavyweight aggregates that meet the requirements of the AREMA specifications for aggregates in the AREMA Manual for Railway Engineering, Volume 2, Chapter 8 "Concrete Structures and Foundations," Part 1 "Materials, Tests and Construction Requirements," Section 1.3 "Aggregates."

   a.) Provide natural aggregates complying with ASTM C33, Class 4S.
   
   1.) Conduct a separate test for each type of cement at 3 and 6-month intervals.
   
   b.) Provide evidence that concrete containing aggregate from the proposed source has a satisfactory service history of at least 5 years when used with cement content and alkali burden similar to the job mix.
   
   1.) This evidence must include structures requiring a Class 4S aggregate.
   
   c.) Provide aggregate having a maximum size of 3/4 inch.
   
   d.) If the coarse or fine heavyweight aggregate is supplied in more than one size, store each size separately.
   
   e.) Allow washed aggregate to drain in stockpiles before use.
   
   f.) Provide aggregate free from ice when used.

2. In addition to the requirements of ASTM C33, use an independent testing laboratory to conduct the following tests:

   a.) For each new source, conduct a petrographic examination in accordance with ASTM C295.
   
   b.) Evaluate potential alkali reactivity in accordance with ASTM C1293.
   
   c.) Test aggregates containing carbonate in accordance with ASTM C586 for evaluation of potential alkali carbonate reactivity.

C. Water Used In Mixing Concrete and Washing Aggregates:

1. Potable and free from harmful amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel.

2. Do not allow chloride ion concentrations in excess of 400-ppm.

3. Mortar test cubes with the proposed mixing water shall have 7-day and 28-day strengths equal to at least 90 percent of strengths of similar specimens made with distilled water. Strength test comparison shall be made on mortar, identical except for the mixing water, prepared and tested in accordance with ASTM C109.
D. Accelerating, Retarding, and Water-Reducing Admixtures: If used, provide water-reducing admixtures, water-reducing and retarding admixtures, and water-reducing accelerating admixtures conforming to ASTM C494/C494M.

1. Do not use admixtures containing chlorides.

2. Do not use air-entraining admixtures as specified in Section 03 05 15 such as fly ash and other list mineral admixtures.

E. Polypropylene Fibers per SECTION 03 24 00 for fire Protection

2.03 REINFORCING BAR

A. In accordance with Section 03 20 00 – Concrete Reinforcing, and provide bars in formed steel complying with ASTM A615, grade 60, ACI 318.

2.04 EMBEDDED ANCHOR INSERTS

A. Provide concrete floating slabs with fastening systems for the purpose of securing direct fixation fasteners, side brackets, trench cap mounting and slab eye bolt lifting system.

1. Provide locations and tolerances of all anchor inserts in accordance with the fastener manufacturer’s drawings and tolerances shown on the Contract Plans.

B. Procure anchor inserts (Type I):

1. Material: Ductile iron grade 65-45-12, tested in accordance with ASTM A536.
   a.) Tensile strength, ultimate: Greater than 65,000 psi.
   b.) Tensile strength, yield: Greater than 45,000 psi.
   c.) Elongation, 12 per cent

2. Internally thread each insert according to the requirements of ASME/ANSI B1.1 7/8 inch Unified National Coarse Thread Series, Class 2B tolerance; and provide a blind bottom as shown on the Contract Plans. Anchor bolts shall be fully threaded into inserts with minimum interference.

3. Anchor Insert Closure Plugs:

   a.) HDPE fabricated threaded plug for 7/8 inch –9UNC threaded inserts as shown in Contract Plans.

2.05 LIFTING EYE BOLTS

A. Provide 7/8 inch diameter heat treated eye bolts 1-11/16 inch internal eye diameter to ASTM A449, SAE J429 grade 5, and having Class 2A and 2B 5 thread fit.
2.06 FORM FREE AGENT

A. Provide a form free agent of a type which will not affect bonding of pads cemented to concrete, or physically or chemically affect elastomeric materials. Do not use petroleum-based oils.

2.07 SURVEY PLAQUES

A. Provide survey plaques to the materials and sizes shown on the Contract Plans.

2.08 SPARE FLOATING SLABS AND ELASTOMER COMPONENTS

A. Spare slabs shall be supplied as spares without attached elastomeric support pads as listed on the Contract Plans

B. Spare elastomeric components including side brackets shall be supplied as spares as listed on the Contract Plans.

C. Provide adhesive for cementing elastomer (rubber) support pads to the recessed underside pockets in the concrete slab – As recommended by pad manufacturer; neither physically nor chemically affecting elastomeric materials

PART 3 - EXECUTION

3.01 CONCRETE FORMWORK

A. Formwork shall be designed and fabricated to meet the requirements of the following:

1. Section 03 05 15 – Portland Cement Concrete

2. Section 03 11 00 - Concrete Forming

3. Section 03 30 00 – Cast-in-Place Concrete

4. Section 03 35 00 – Concrete Finishing

B. Generate formwork to provide the shape and configuration of the two types of floating slab with accurate mountings for anchor inserts to the tolerance shown on the Contract Plans and as stated in the reference Sections.

C. Radius all floating slab corner to 1 inch radius and the 4 inch trench radius corners as shown on the Contract Plans.

D. The formwork shall be precision fabricated steel in accordance with ACI 347 to achieve the complete designed shape of the floating slabs generating the tolerance dimensions shown on the Contract Plans.

E. Repair of Defects:

1. Segments which exhibit structural damage that will impair the ability of the segment to perform as required, in the opinion of the Resident Engineer, will be rejected. Examples of this type of structural damage include cracks greater than 0.008 inches wide through
the full thickness of the segment; multiple cracks at joint bearing areas or inserts spalling, chipping or cracking that exposes rebar; and honeycombing,

2. For non-structural defects or damage, repair segments per approved repair procedures. Provide repair procedures for patching of blow holes and air voids; chipping and spalling; local protrusions; localized surface cracking; structural cracks less than 0.008 inches; and honeycombing not adjacent to bearing areas.

3. For minor non-structural defects not located at bearing areas and less than 3/16 inch in depth, no repairs are required.

4. Do not transport repaired segments to the Site prior to approval of repairs by the Resident Engineer.

3.02 SLAB POURING, MOLDING CURING AND CONCRETE FINISHES

A. Floating slab fabrication shall follow the requirements listed in 1.01 to provide the finish described in Section 03 35 00 – Concrete Finishing as follows:

1. Top, side, end and rail trough surface finish to conform to ACI 301 tolerance for surfaces exposed to public view.

2. Underside surface finish to conform to ACI 301 tolerances for permanently exposed surfaces where other finishes are not specified, except support pad bearing areas shall be treated as specified in 3.02B.

3. Consolidate concrete floating slabs as specified in Section 03 30 00, Article 3.02C Consolidating.

B. Recessed Surfaces for Support Pads – Concrete slab in the bottom up position shall have a grinding wheel finish to a depth to provide tolerance dimension from bottom of rail trough to recessed surface as shown on the slab fabrication Contract Plans L10-KD231 and L10-KD232.

1. Depth of recessed surface grinding score markings shall not exceed 1/16 inch.

C. Recessed formed end pad surfaces shall not be roughened.

D. Curing:

1. Cure segments and protect during storage in accordance with ACI 533 and ACI 517.2R.

2. If Steam Curing is Used:

   a) After the segments are cast and attained preset time, place the segment forms in an enclosure or chamber large enough to allow complete circulation of steam.

   b) Do not remove segments from forms until the required stripping strength is attained, as determined by test cylinders.

   c) Provide enclosure or chamber ambient temperature that does not exceed 100 degree F for the first 2 hours of curing; maintain temperature between 90 degree F to 150 degree F until the required stripping strength is attained. Continuously monitor temperatures during curing.

   d) Control cooling rate to limit temperature differential to avoid thermal cracking.

   e) Apply an approved curing compound on all surfaces immediately after removal of segments from steam curing.
3.03 FLOATING SLAB DIMENSIONAL TOLERANCES

A. Formwork shall produce a length and width of slabs: plus or minus 1/4 inch.

1. Depth of floating slab shall be plus or minus ¼ inch except when specific tolerances are shown on the Contract Plans and stated herein.

B. Square shape: 90+/-1 degree for all corner locations.

C. Rail trough bottom to recessed support pad surface: plus or minus 1/16 inch.

D. Each slab shall weigh:
   1. Slab 3'-10"  11,000 pounds +/- 500 pounds.
   2. Slab 7'-10" 22,000 pounds +/- 500 pounds including trench cap.

3.04 SURVEY PLAQUE APPLICATION

A. Drill and counter bore floating slab for application of survey plaque as shown on Contract Plans. Locate survey plaques to an accuracy to place the plaque central to the tolerance dimension.

B. Adhere the plaque in place.

C. The true accuracy and tolerance for the slab centerline of track marking on the plaque surface shall be determined by measurement from the fastener insert locations and be pin-pointed on the plaque surface by chiseled cross hairs.

3.05 SUPPORT PAD APPLICATION

A. Bond (glue) support pads to the underside prepared recessed surfaces with approved adhesive agent as shown on the Contract Plans. See special transition type support pad requirements as described in Article 3.05B and as shown on the Contract Plans.

B. For transition slabs with special type IV, III and II support pads clearly mark top of slab with numerals matching the special support pads applied to the slabs. Identification marking shall be in 12 inch diameter black circles with Roman numerals as shown on the Contract Plans.

C. Degrease all concrete surfaces of excess form release agents.

D. Thoroughly clean underside circular recessed depressions with forced air for application of support pad adhesive. The surfaces both the concrete and the rubber shall be prepared in accordance with the recommendations of the adhesive manufacturer.

E. Apply adhesive to underside recessed depression for application of support pads and secure support pads.

F. Bond rubber support pads to floating slab structure using a compression application with accepted bonding agent. Centrally place the support pads within the recess using equal
width spacers or ring to confirm central position of support pad. Tolerance for support pad position within the recess shall be plus or minus 1/8 inch on center.

3.06 SLAB TESTING PROCEDURES AND REQUIREMENTS

A. Test slab configuration to conform to the sizes and tolerance stated.

B. Confirm all anchor inserts are located correctly by formwork arrangement to the tolerances stated prior to commencement of production slabs.

C. Test slab for weight within the stated weight tolerance to confirm proper density and lack of voids.

D. Develop a quality control program for the internal concrete integrity per Section 03 30 00 confirming quality of concrete mass of the slab.

1. Undertake sectionalizing the first concrete slab to verify and confirm consolidated concrete conditions by mechanical vibration

2. If directed by the Resident Engineer, obtain drilled cores of concrete from every 30th floating slab after the first sampling if deemed necessary due to quality by the Resident Engineer.

3. Floating slabs which have been sectioned or cored shall not be used in construction.

E. Test bonding (gluing) of vertical support pads to the precast concrete floating slab in the underside provided recessed pocket. Perform tests to evaluate the bond as recommended by the pad manufacturer.

F. Two floating slabs out of 30 production floating slabs shall be tested for complete accuracy to be certain the production procedures are producing the required accurate floating slabs. A steel measuring device graduated in 1/32 inch increments shall be used to confirm positions.

G. The recessed trough for rail fasteners shall be straight edge tested for level and a consistent slope to 1/8 inch over the length of the slab.

END OF SECTION
PART 1 - GENERAL

1.01 SUMMARY

A. Description:

1. Requirements for installation of fixed tunnel invert cast-in-place plinths for eventual floating slab support pad installations.

2. Requirements for installation of prefabricated floating slab sections in an existing circular tunnel section containing abbreviated vertical side walls for the eventual installation of direct fixation track containing continuous welded rail (CWR).

3. The requirements of this Section supplement the requirements of Section 34 72 10 – Track Construction.

4. The Work includes all ancillary activities as may be required to complete an acceptable floating slab system.

B. Section Includes:

1. Site Examination
2. Preparation
3. Demonstration Section
4. Floating Slab Alignment, Profile, and Geometry
5. Concrete Plinth and Invert Construction
6. Floating Slab Installation
7. Southbound Track Installation
8. Tolerances
9. Repair of Floating Slabs
10. Field Quality Control

C. Related Sections:

1. Section 01 33 00 - Submittal Procedures
2. Section 01 45 00 - Quality Assurance/Quality Control
1. Section 01 66 00 – Product Storage and Handling Requirements

2. Section 03 05 15 – Portland Cement Concrete

3. Section 03 11 00 – Concrete Forming

4. Section 03 15 00 – Concrete Accessories

5. Section 03 20 00 – Concrete Reinforcing

6. Section 03 30 00 – Cast-In-Place Concrete

7. Section 03 35 00 – Concrete Finishing

8. Section 03 62 00 – Non-shrink Grouting

9. Section 13 48 11 – Elastomer Isolation Pads

10. Section 34 11 27 – Precast Concrete Floating Slab Fabrication

11. Section 34 11 36.14 - High Resilience Direct Fixation Fasteners

12. Section 34 72 10 - Track Construction

1.02 REFERENCES

A. American Concrete Institute (ACI)

ACI 503.4  Standard Specification for Repairing Concrete With Epoxy Mortars

B. American National Standards Institute/ American Society Mechanical Engineers (ANSI/ASME)

ANSI/ASME B1  UNC Thread – Unified National Coarse Thread

C. ASTM International (ASTM):

1. ASTM A449  Standard Specification for Hex cap Screws, Bolts and Studs, Steel, heat Treated 120/105/90 ksi Minimum tensile Strength, General Use

2. ASTM A536  Standard Specification for Ductile Iron

3. ASTM C827  Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

4. ASTM C881  Standard Specifications for Epoxy-Resin-Base Bonding Systems for Concrete

5. ASTM C1107  Standard Specification for Packaged Dry, Hydraulic Cement Grout (Non Shrink)

1.03 DEFINITIONS

A. Definitions of terms used in this Section shall be in accordance with Section 34 72 10 – Track Construction.

1.04 SUBMITTALS

A. Procedures: Section 01 33 00 – Submittal Procedures

1. Relevant submittals as indicated in Section 34 72 10 – Track Construction.

2. Construction Work Plan in accordance with Article 3.02 of this Section.

3. A survey of the existing “as-built” positions of the tunnel walls and invert alongside and on which the floating slabs will be installed as specified in Article 3.01 of this Section.

4. Product Data: Manufacturer’s performance sheets, drawings, material specifications, installation instructions, and requirements for handling, storage, and protection for the following.,

   a.) Concrete for tunnel invert plinths per Section 03 05 15
   b.) Concrete reinforcement for tunnel invert plinths per Section 03 20 00
   c.) High density polyethylene (HDPE grit/coarse finish) corrective shims for tunnel invert plinths
   d.) Adhesive (bonding agent) for invert shim gluing
   e.) Adhesive (bonding agent) for End Separation Pad application
   f.) Cementitious grout for tunnel wall anchor inserts
   g.) Anchor bolts for side bracket mounting to floating slab
   h.) Anchor bolts for side bracket mounting to vertical tunnel walls
   i.) Sand Catcher Channels with Sleeve-All type anchors for round headscrews and washers
   j.) Duct Tape for side bracket epoxy application
   k.) High Resilient Fasteners with anchor bolts if decision to apply before slabs are pre-fitted before slabs are taken into tunnel
   l.) Other incidental materials provided by the Contractor that are necessary to provide a complete installation of floating slabs.
5. Shop Drawings:

a.) Concrete connecting reinforcement details for tunnel invert plinth installation.

b.) Concrete tunnel invert plinth installations. Concrete tunnel base plinths at tunnel inverts for eventual floating slab support pad installations. Provide drawings indicating the layout of all floating slab plinths detailing their relationship to the as-built vertical tunnel wall and invert surfaces upon which they will be constructed. Show longitudinal side wall drainage requirements at low side plinths and escape transverse drainage depressions between the eventual positions of the floating slab support pads to promote complete invert drainage.

c.) Facilitate the work of other trades who must position ducts and cables beneath or on top of the track plinth system, and other physical conditions.

d.) Installation details showing interfaces with the work of other trades.

e.) High Density Polyethylene (HDPE grit/coarse finish) corrective elevation shims for support pad concrete plinths.

f.) Method of installation and preparation of concrete surface for epoxy bonding agent for elevation shims when required.


7. Procedures:

a.) Procedures for transporting floating slab sections (3'-10" and 7'-10" sizes) from Seattle site storage to the tunnel installation location. Procedures for placing and installation for both types of floating slab sections (3'-10" and 7'-10" sizes) in relation to Electro-Magnetic Interference (EMI) cable.

b.) Procedures for installation of side wall anchor inserts for side brackets, detailing marking and drilling of walls.

c.) Procedures for confirming floating slabs are in position according to centerline of track alignment - vertical and horizontal.

8. Test Results: Wall anchor Insert tests (pullout and torque) in accordance with Article 3.09 herein.


10. Qualifications

11. Miscellaneous: Submit product data and shop drawings for any materials provided as part of the Work of this Section that do not have requirements for such submittals specified in other Sections.
1.05 QUALITY ASSURANCE / QUALITY CONTROL

A. General: Refer to Section 01 45 00 – Quality Assurance / Quality Control, for quality assurance and control requirements and procedures.

B. Testing Laboratory:

1. Qualification Tests and Production Quality Control Tests shall be performed by an independent testing laboratory or independently monitored in-house laboratory. Employment of an independent laboratory does not relieve the Contractor of his obligation to perform the Work in accordance with requirements of the Contract Specifications and Contract Drawings.

2. Location: Testing shall be conducted within the continental United States of America.

3. Selection of Testing Laboratory: Subject to approval by the Resident Engineer.

C. Qualifications:

1. Trackwork Superintendent shall have at least 15 years of experience in construction, with at least 10 years experience in railway track construction and maintenance, at least 5 of which shall be in construction of trackwork for an electrified rail transit system, and at least 2 years of experience in direct fixation track construction. The Superintendent shall have at least 10 years of experience at a level of Foremen or above.

2. Trackwork Foreman shall have at least 7 years experience in construction with at least 5 years experience in railway trackwork, not less than 2 years in the construction of the types of track to be constructed under the Contract, and not less than 2 years experience at the Foreman level.

3. Precast concrete installer Foreman with 3 years experience in the precision structural construction work or similar complex installations.

D. Quality Plan:

1. Comply with the requirements of Section 01 45 00 – Quality Assurance / Quality Control for preparation of a Quality Plan.

2. Incorporate the following:

   a.) Tunnel invert surface preparation measurements.

   b.) Environmental measurements such as temperature, relative humidity and similar items.

   c.) Mixing, applying, and curing measurements such as component materials viscosity and density, mixing ratios, and material hardness at various cure times.

   d.) Provisions addressing test failure and retesting procedures.
E. Demonstration Section: Construct a demonstration section of tunnel floating slab installation for direct fixation track as indicated in Article 3.03 herein. Do not employ other construction methods unless approved by Sound Transit.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Handle all trackwork materials in accordance with Section 01 66 00 – Product Storage and Handling Requirements and the following:

1. Transport floating slabs in a horizontal position and braced to prevent movement that could cause damage. Handle slabs only by the embedded eye bolts and in accordance with the manufacturer’s recommendations.

2. Protect underside slab support pads by providing ample dunnage size to prevent support pads from being used to support the slabs until they are actually installed in the tunnels.

3. Control the slab locations by identity of Type IV, III and II with special transition support pads for application at the beginning and ending points of the floating slab segment per the Contract Plans.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Furnish all materials required to construct the tunnel invert plinth and the placement of floating slabs for the floating slab segment of direct fixation trackwork shown in the Contract Plans, including but not limited to the following:

B. Floating Slab Types:

1. Provide precast floating slabs 3’-10” and 7’-10” sizes per Section 34 11 27.


D. Sand Catcher Channel and Sleeve-All Type Anchor Screws:

1. Provide sand catcher channels and Sleeve-All Anchor screws per Contract Plan L10-KD236

2. 

E. Invert Plinth Concrete:

1. Provide concrete meeting the requirements of Section 03 05 15 – Portland Cement Concrete and Section 03 30 00 – Cast-In-Place Concrete

2. Plinth Concrete: 4,000 psi minimum strength per Section 03 05 15, Table 03 05 15.A.

F. Concrete Reinforcement: Provide uncoated steel reinforcement bars in accordance with Section 03 20 00 – Concrete Reinforcing, per the Contract Plans.
1. All plinth reinforcement shall be securely fastened to the tunnel invert as shown on the Contract Plans.

2. Special Hook Tie Bars: In superelevated tunnel invert track sections provide a series of reinforcing hook tie bars to generate the stepped-up installation shown on the Contract Plans.

3. Tie Wires: For reinforcement bar connections shall be No 16 gage or heavier.

G. Tunnel Invert Corrective Elevation Shims:

1. High-Density Polyethylene (HDPE sand/grit finish) per ASTM D4976. The shim shall be 24 inches in square providing ample coverage of where the floating slab support pad will rest and of a thickness to correct the elevation discrepancy.

2. High Density Polyethylene (HDPE) Vertical Plinth Corrective Adjustment Shims:

   Provide shims of various thicknesses as required to correct for tunnel invert plinth elevation discrepancies in graduated thicknesses so that only one shim will be required for all increments in 1/16-inch thickness.

   a.) Shim material shall conform to the requirements for insulating shims in Section 34 11 36 – Direct Fixation Fasteners, except the shim material shall have a sand/grit textured finish.

H. Polyurethane:

1. Tunnel invert finish shall include a drainage chase consisting of a coating of polyurethane to transition the invert elevation at the joints.

I. Embedded Anchor Inserts for Tunnel Walls:

1. Anchor Inserts (Type II): Ductile iron grade 65-45-12, tested in accordance with ASTM A536.

   a.) Tensile strength, ultimate: Greater than 65,000 psi.

   b.) Tensile strength, yield: Greater than 45,000 psi.

   c.) Elongation: 12 per cent

2. Internally thread insert according to the requirements of ANSI B1 7/8 inch Unified National Coarse Thread Series, Class 2B, tolerance as shown on the Contract Plans.

J. Anchor Bolts for Side Bracket Mounting:

1. 7/8 inch -9 UNC diameter anchor bolt x 3 inch long for mounting side bracket to sidewall Type II embedded anchor.

2. 7/8 inch -9 UNC diameter anchor bolt x 3-3/4 inch long for mounting side bracket to floating slab Type I embedded anchor.
K. Epoxy Resin for Repair of Floating Slab Cracks:

1. Provide epoxy resin for repair of floating slab cracks (damaged in transit) deemed repairable by Sound Transit. Refer to Article 3.11G.5 for crack criteria.

2. Epoxy resin shall be a low-viscosity, moisture-tolerant epoxy resin, crack healer/penetrating sealer as Sika Corporation product Sikaadur 55 SLV or approved equal.

L. Epoxy Mortars for Repair of Floating Slab Chips:

1. Epoxy mortars shall be in accordance with ACI 503.4.

M. High Strength Grout:

1. Provide High Strength Grout cement-based, non-metallic, non-shrink grout for securing side bracket wall anchor inserts that require post positioning based on floating slab centerline alignment.

2. High Strength Grout material (cement-based) grout shall conform to Five Star High Strength Grout and tested in accordance with ASTM C 827.
   a.) The grout shall exhibit positive expansion and meet the requirement of ASTM C1107-02 Grades A, B and C; and CRD-C 621-93 Specifications for non-shrink grout.

N. Provide all other materials incidental to the construction of floating slab work that are necessary to provide a complete and acceptable floating slab installation providing the function and appearance, as specified and necessary. Submit Product Data for all materials provided for the approval of Sound Transit.

2.02 EQUIPMENT

A. Comply with the equipment requirements specified in Section 34 72 10 – Track Construction.

PART 3 - EXECUTION

3.01 SITE EXAMINATION

A. Undertake a tunnel alignment Site Examination as follows:

1. Thoroughly inspect tunnel invert liner conditions and existing side wall positions, list any deficiencies which will interfere with floating slab invert plinth installations and inform Sound Transit of abnormal alignment conditions which require correction before floating slab invert work may start.

2. Review other service system conduits in-place that interface with plinth installation for complete understanding of procedures.

3. Perform an as-built condition topographic survey of the tunnel through the floating slab portion of the alignment, accurately determining both horizontal and vertical conditions. Determine if existing work conforms to the tolerance requirements of the Contract under which it was built. Include the following in the survey:
a.) Horizontal and vertical wall positions, including measurements of the location of breaks in chorded construction. Collect location data at not less than 10 foot intervals along the tunnel length. Determine the wall position and its vertical accuracy (plumbness) and lateral position at the position where each floating slab side bracket will be mounted.

b.) Elevations of the tunnel invert including any changes in direction or twist that would require correction before it would be possible to install floating slab to the design shown.

c.) Note all defects, including out of tolerance locations, and prepare a comprehensive survey report noting as-built alignment (horizontal and vertical) compared to design alignment; wall positions (horizontal and vertical) as to design requirements; finish of tunnel walls and invert as to conditions acceptable for floating slab plinth installation.

d.) Generate a three-dimensional CADD model of the surfaces surveyed and provide the CADD file to the Resident Engineer for use in generating the Best Fit Alignment described at Paragraph 3.01 C below.

e.) Prepare a comprehensive Tunnel Invert As-Built Survey Report inclusive of the requirements in the paragraphs a.) through d.) above.

4. 

5. 

B. Have deficiencies corrected by the responsible party prior to commencing floating slab plinth installation

C. The Resident Engineer will arrange for the Designer of Record to review the as Tunnel Invert As-Built Survey Report. The Designer of Record will determine whether, based on the as-built information, the proposed track alignment should be revised so as to best fit the actual tunnel location. If so, the Designer of Record will generate that revised alignment (the Best Fit Alignment) which will then supercede the alignment given in the bid documents. Any such revised alignment will be furnished to the Contractor with 60 calendar days of the date when an acceptable Tunnel Invert As-Built Survey Report has been submitted.

D. Construction of any of the plinths for supporting floating slabs, or any construction of conventional non-floating direct fixation track adjoining floating slab track, including construction stakeout, prior to receipt of the Best Fit Alignment is at the Contractor's sole risk.

E. 

3.02 PREPARATION

A. Construction Work Plan: A minimum of 90 days prior to beginning the Work specified in this Section, submit a detailed Construction Work Plan, per Section 01 45 00, describing the installation procedures required for the Work of floating slab invert plinth structure, including but not limited to the following:

1. All applicable requirements as stipulated herein and related Sections.
2. Specific preparation and installation procedures for transporting and placing formwork with reinforcing bar details for floating slab tunnel invert plinths considering superelevated conditions. Include list of transporting and working equipment required.

3. Specific preparation and installation procedures for transporting and placing concrete for floating slab invert plinths. Include list of transporting and working (pump) equipment required.

4. Include details with drawings pertaining to the components to be used, methods, templates, fixtures and methods to protect adjacent conduits during the concrete placement.

B. Roughen the tunnel liner surface by light jack hammer process or other acceptable means of providing a securing surface for bond between the plinth concrete and the tunnel liner. Remove all loose laitance and debris by compressed air from the tunnel invert surface that will be in contact with the concrete plinth immediately before placing plinth concrete.

3.03 DEMONSTRATION SECTION

A. To confirm the proposed procedure for the construction of the floating slab plinths, construct a demonstration section not less than 120 track feet in length consisting of two EMI splice trench pair of slabs. Demonstration section shall be a continuous segment of curved track including the stated superelevation commencing at the beginning-of-floating slab track station stipulated on the Contract Plans.

B. Demonstration section is subject to final acceptance from Sound Transit prior to become a segment of the final track.

C. If the demonstration section installation (or portion thereof) is unsatisfactory deemed by Sound Transit, it shall be demolished, a revised construction procedure proposed, and a new demonstration section constructed in the same location at no cost to Sound Transit.

D. Production construction of floating slab invert plinths (beyond the demonstration section) will not be permitted until the designated demonstration section has been accepted.

E. Once the demonstration section and methods have been accepted, construction methods other than those used to build the accepted demonstration section shall not be employed unless approved by Sound Transit through construction of a new demonstration section for approval.

3.04 TRACK ALIGNMENT, PROFILE, AND GEOMETRY

A. Provide invert plinth alignment, profile, and geometry in accordance with the requirements specified in Section 34 72 10 – Track Construction to allow eventual floating slab direct fixation track.

B. Construct plinth concrete for floating slab track conforming to the alignment and profile data shown on the Contract Plans or the informed corrective “best fit” alignment.

3.05 CONCRETE PLINTH AND INVERT CONSTRUCTION

A. General: Construct concrete plinths in accordance with Section 03 05 15 Portland Cement Concrete, Section 03 11 00 –Concrete Forming, Section 03 15 00 – Concrete Accessories,
B. Inspect existing tunnel liner surfaces roughen areas where the plinths will be constructed as specified in Article 3.01 and Paragraph 3.02 B of this Section.

C. Reinforcing Steel Anchorage: Stirrups for anchoring the plinth concrete to the concrete tunnel liner shall be grouted into holes which have been drilled, not cored, into the tunnel liner.

1. Drilled diameter of the holes shall be as recommended by the manufacturer of the cementitious grout used.

2. Arrange holes so as to be a minimum of 6-inches from any joint between tunnel liner segments and to have not less than 1-inch of clearance to any reinforcing steel in the tunnel liner segments. Depth of the holes into the tunnel liner shall be not less than 4 ¼ inches and not greater than 4 ½ inches.

3. Custom bend reinforcing steel stirrups so as to match the as-drilled location of the anchorage holes and provide not less than the specified minimum concrete cover to the external surfaces of the plinth.

4. Grout reinforcing steel stirrups into the tunnel line in accordance with grout manufacturer’s printed recommended procedures. Provide templates or other temporary supports as may be necessary to hold stirrups in proper orientation during curing of the grout.

5. After grout has cured, inspect the reinforcing bar stirrups for tight anchorage into tunnel invert. Stirrups shall be securely fastened down with no rotation or upward movement possible.

D. Complete construction of plinth reinforcing steel in accordance with indicated requirements.

E. Plinth Construction: Comply with indicated requirements and the following:

1. Formwork: The plinth formwork must be positioned precisely with exact screed lines to establish the top of plinth surfaces to the height and corresponding transverse and longitudinal slopes to match super-elevated track conditions. The low rail sets the invert plinth surface height (elevation) based on the set distance from top-of-rail to top of plinth as shown on the Contract Plans.

2. Tolerances: The concrete plinths shall be constructed to tight tolerances so as to provide full and proper support to each of the 12.5 inch diameter floating slab support pads. Provide a 24 inch square uniform continuous bearing surface at each support pad location. All plinth surfaces for each discrete floating slab (four for a standard 3’-10” floating slab, eight for a 7’-10” utility splice floating slab) must be accurate to the correct height and track gradient slope within +/- 0.01 foot (1/8 inch) for the plinth surface tolerance. In curved tracks, this tolerance must be maintained through spirals and the central portion of the curve so that the plinths surfaces are sloped parallel to the super-elevated top-of-rail plane. The surfaces at the four (or eight) supporting pad locations under each of the floating slab sections shall be consistent with the track grade and super-elevation so that each floating slab supporting pad is equally loaded when the floating slab is in place.
3. Finishes: Finish the concrete surface area for each support pad with a uniform steel-trowel cement burlap finish to provide uniform continuous bearing surface capable of providing full contact with either the support pad of for an HDPE corrective elevation shim, if shimming is required. Comply with criteria cited in Article 3.11 herein.

F. After removal of the formwork for the plinths, the remaining central portion of the tunnel liner invert between the placed vertical plinth faces at this point in construction shall be completed by placing and forming an invert protective polyurethane invert surface for drainage of tunnel.

G. From the required tunnel invert accuracy survey determine whether the as-built tunnel plinth surface vertical positions are accurate or to determine if additional shimming or grinding is required. Additional shimming (if required) shall be permanently bonded (glued) to plinth surface. For high plinth pours grind the surface in a single accurate plane (24 inches in diameter at the location of where the support pad will rest. The grinding surface shall be sand grit finished to provide additional friction. The work and materials required for correcting plinth surfaces shall be at no additional cost to Sound Transit.

H. After corrective steps the installation shall be checked for acceptance to support the floating slab support pads. Once accepted by Sound Transit the installation of floating slabs may commence.

3.06 FLOATING SLAB INSTALLATION-GENERAL

A. The following floating slab description of installation is a suggested sequence only and the eventual method shall be at the discretion of the Contractor and as detailed in the submitted Contractor's Work Plan.

B. Electro-Magnetic Interference (EMI) Cable placement steps must be taken to initially place the EMI cable on the formed tunnel polyurethane invert surface below the slabs on the projected track and floating slab centerline. The previously placed polyurethane invert shape shall assist in holding the EMI cable on the correct centerline of track position. The floating slabs have been purposely designed to allow the cable to rest on top of tunnel invert during placement of the floating slabs. The method of hanging the EMI cable between the floating slabs within the 2 inch open gaps requires that a series hanging harnesses be positioned along the cable for future handling and eventual final tolerated elevation positioning.

C. With the survey of the inspected and accepted invert plinth elevation installation and the initial placement of EMI cable, the Trackwork Contractor shall commence distributing and/or placing the floating slabs. The floating slabs shall be handled right side up with their built-in eye bolt lifting system. The slabs require handling with caution to avoid disturbing the pre-bonded underside rubber support pads, retaining the integrity of the concrete slab itself and setting down slabs so that the underside center of slab slot is over the centrally placed EMI cable.

D. NOTE: Prior to the distribution of floating slabs, the Trackwork Contractor has the option of pre-installing the direct fixation fasteners on the slabs to facilitate distribution of fasteners.

3.07 SOUTHBOUND TRACK INSTALLATION IN A NORTHERN DIRECTION

A. Installation shall begin at Southbound Track Station 1069+30 with placement of the first floating slab segment, also the beginning of the Demonstration Section adjacent to the special concrete plinth fixed invert direct fixation track; the first floating slab (3'-10" length and without side brackets in place) specifically marked IV with corresponding Type IV transition base support pads will be positioned to meet the specially designed wider fixed direct fixation
track plinth end wall. The special concrete plinth end wall faces must be constructed wider to meet the pre-set positions of the end separation pads on the floating slab to longitudinally support the end separator pads after floating slabs are in place as shown on the Contract Plans.

B. With the first floating slab in surveyed position on the track centerline (using the slab surface survey plaques) and using a 2 inch wide longitudinal spacer block between the floating slab end face and the fixed direct fixation track invert plinth end walls, the Contractor shall temporarily assemble and loosely bolt the side brackets, extend the brackets to butt the tunnel side walls and mark the required two bracket bolt mounting positions for wall drilling for the anchor inserts. In locations of a slightly uneven non-tangent wall section, at the bracket location, non-conforming to the tolerances for the vertical side walls, the wall surface shall be lightly ground to generate a flush bracket to wall surface contact.

C. Based on the expected size of the drilling and pneumatic wrench equipment, the floating slab surface has been purposely fabricated with half-moon voids/depressions to accommodate the position of the equipment when core drilling and applying the bolted bracket wall connections. Remove mounted side brackets to allow side wall drilling.

D. The suggested procedures for floating slab installations are as follows:

1. The drilled wall holes shall be prepared by heavy roughening and inverted tapering of the smooth drilled hole internal surfaces to provide additional High Strength cement bonding then thoroughly cleaned out by air gun

2. Prepare the bracket for installation by placing a non-stick surface adhesive tape to the backside of the bracket to act as an cement bond breaker

3. Place the two wall anchor inserts in the cored wall holes and hold with vise grips

4. Mount the side brackets with loosely mounted bolts to the floating slab and push bracket up to the vise grip held inserts

5. Apply wall anchor bolt and washer to adjusted position of anchor insert for fully applied (torque) bolt arrangement

6. Remove vise grips and place side bracket hard against tunnel wall

7. Complete the bolting of side bracket to slab by torque of mounting bolts

8. To complete the installation survey the slab position relative to centerline of track and adjust as required using the embedded survey plaques to position slab on track.

E. Although the vertical side walls are specified to be vertical to a tolerance of 1/8" in 12" the plate to wall contact may not be completely flush, therefore seal the perimeter edges of the bracket wall plate with retaining duct tape. With the bracket pressed and taped against the side wall inject epoxy grout, via the provided application holes in the plate, in accordance with manufacturer’s directions for application. Fill anchor insert drilled cavity and inject to refusal so that any unwanted bracket to wall voids are completely filled providing a flush surface for the side bracket.

F. **Caution:** Do not commence complete install of floating slab by adjusting for pre-stressed side pads and end separation pads until High Strength cement grout has reached “load time”
by either heating the concrete or duration of time as specified by the manufacturer or supplier of the cement grout product. Once grout has been allowed to cure to final cure time strength further floating slab installation may continue.

G. Once wall anchor inserts have obtained permanent load set with brackets torque to side walls undertake pre-stressing of side bracket pads to the following procedure:

1. To shift floating slab to the right, place hydraulic jack between left tunnel wall and side of floating slab surface. Use two jacks if required to square floating slab to chorded tunnel wall.

2. Jack (push) the floating slab toward the right wall, a distance of approximately 0.1 inch beyond centerline.

3. Secure left side bracket to floating slab surface and torque mounting bolts to 400 ft/lbs.

4. Release hydraulic jack(s) allowing slab to seat itself to the left, slightly compressing left side bracket pad.

5. To shift floating slab to the left, place hydraulic jack(s) between right tunnel wall and side of floating slab surface.

6. Jack (push) the floating slab toward the left wall, further compressing the left side bracket pad, approximately 0.15 inch beyond centerline.

7. Secure right side bracket to floating slab surface and torque mounting bolts to 400 ft/lbs.

8. Release hydraulic jack(s) allowing slab to seat itself, check slab position to centerline of track alignment.

9. Repeat adjustment, if necessary, to set required centerline of track floating slab alignment using the survey plaques.

H. At the first two inch opening between the end walls of the fixed invert plinths and the floating slab face place a small jack (hydraulic spreader/jack) to open the 2 inch gap to allow placement of the two end separator pads, gluing one contact side of the pad in place. The side brackets with sandwiched rubber isolation will retain the longitudinal position of the installed slab with minor side bracket rubber distortion.

I. Remove the lifting eye bolts from the embedded insert and install plastic threaded inserts flush with top of floating slab surface.

J. Strip the retaining tape from around the side bracket plate at the wall surface.

K. The final step in floating slab installation will be application of the rail trough sand catcher channels. To protect sand catcher channels during additional trackwork to complete track, undertake this installation once total direct fixation track is installed and accepted. Attached the sand catcher channel by drilling and grouting the All-Sleeve inserts on the high side of the 2 inch floating slab gap as shown on the Contract Plans. Two Sleeve-All type anchors should be used to attach the channels. The sand catcher channels of Santoprene Thermo Plastic Rubber should be allowed to flex with the independent movement of the slabs considering attachment at only one end.
L. For future retrieval of the EMI cable the hanging harness extension (laying on the tunnel invert) within the 2 inch gap opening between slabs, tape the EMI harness hanger to the face of the first placed floating slab for easy retrieval when second slab is in place. Place the second floating slab marked IV with Type IV transition base support pads using a 2 inch wide spacer block between the two floating slab end faces. Repeat these installation steps for complete installation of second slab with taped EMI cable harness in position. The first two slabs will be Type IV transition type; the next three slabs will be Type III; the fifth and sixth slabs will be Type II. These special transition slabs will be paint marked on the surface for easy recognition as shown on the Contract Plans. The floating slabs marked with special transition support pads, marked Types IV, III and II must be installed in the order shown on the Contract Plans. A similar arrangement of transition floating slabs in reverse order with an equal amount of different support types will be installed at the terminus of the floating slab segment, these terminating slabs will all be 3'-10” long slabs.

M. The EMI cable at the start of floating slab track of the work will extend for approximately 40 feet to the first splice connection position as shown on the Contract Plans. At this location two 7'-10” splice trench slabs (with mounted trench caps) will be installed back to back providing the required 8 foot long access splice trench. The last portion of the EMI cable will have to be threaded into the splice trench through the provided opening in the bottom of the slab and then slip the fully suspended slab into position and lower to the fully supported pad to plinth invert state. The adjacent butting 7'-10’ slab will have to be positioned in a similar manner. The next open splice trench location will be 60 feet away through eleven standard 3'-10” slabs and two splice 7'-10” slabs as shown on the Contract Plans. The methodology of invert placing the EMI cable with hanging harness connections through this group of slabs will be similar.

3.08 SOUTHBOUND TRACK INSTALLATION CONTINUED:

A. Repeat the above installation procedures for the next 440 feet to the end of floating slab installation (Sta1073+70) at which time the track type will change to fixed direct fixation tunnel track as shown on drawing L10-KD239. The end of floating slab installation will be similar to track installation shown on Contract Plan L10-KD239 except to mirror image. The special tapered side bracket with tapered plates will be required to compensate for the constant sloped superelevation and the vertical wall within this floating slab track zone.

B. To be certain the floating slabs have seated themselves into their initial vertical position allow a minimum of 15 days before commencing direct fixation track installation. With a conditional acceptance of the floating slab system, in both vertical and horizontal positions, the final direct fixation fastener installation with rail installation may commence. Note the rail to be installed will be continuous welded rail (CWR) prepared (welded) and distributed on rollers throughout the tunnel floating slab segment.

3.09 TOLERANCES

A. Completed direct fixation track on floating slabs shall conform to the track construction tolerances as specified in Section 34 72 10 – Track Construction.

B. Concrete invert plinth tolerance:
   1. Minimum concrete cover over all invert plinth reinforcing bars: 1-1/2 inches.
3. The tolerance for initial invert concrete pour elevation is set at plus 0, minus 1/8 inch. It is recommended that the Contractor work to a tighter tolerance than that during initial installation to reduce the corrective measures of establishing the eventual required plinth elevation surfaces as outlined below.

4. Once the invert plinth concrete has set, theoretical support pad positions will be surveyed for accuracy. Plinth surfaces found high shall be ground down to the specific height required. Plinth surfaces found low will be shimmed as necessary to establish the correct height. Any corrective shimming to be placed on the plinth invert must match the complete invert surface area in the vicinity of the support pad and be bonded (glued) to the plinth surface for permanent installation. Providing the corrective shim material in the quantities required shall be the responsibility of the Contractor.

5. Support pad continuous bearing surface must generate a completed direct fixation track condition to be within a tolerance of plus or minus 1/8 inch in 15 feet of the correct longitudinal slope and plus or minus 1/8 inch in 3 feet in cross slope.

3.10 REPAIR OF FLOATING SLABS

A. Floating slab cracks generated after fabrication acceptance shall be repaired according to the manufacturer’s literature as to mixing, application and limitations refer to Products Article 2.01K.

B. Floating slab chips generated after fabrication acceptance shall be repaired according to the manufacturer’s literature as to mixing, application and limitations refer to Products Article 2.01L.

3.11 FIELD QUALITY CONTROL

A. Invert Plinth Concrete:

1. Do not place concrete that is delivered without the required batch documentation in accordance with Section 03 30 00 - Cast-In-Place Concrete. Missing or incomplete concrete test data will be construed as noncompliance.

2. Remove and replace plinth concrete failing to comply with the requirements of both this Section and Section 03 30 00 – Cast-In-Place Concrete, at no to Sound Transit.

3. Concrete plinth surface finish and tolerance shall be as stated.

4. Concrete support pad invert plinth bearing areas finish:

   a.) Uniformity, surface bearing acceptance criteria:

   The finished vertical surface parallel to the top-of-rail plane shall be within plus zero, minus 1/8 inch whether established by either the preferred method of finished cast-in-place concrete or the alternative additional secondary corrective shimming.

B. Side Wall Anchor Insert (Type II) Tests:
1. During the construction period, conduct anchor insert restrained pull-out test, unrestrained pull-out test, and torsion test with separate concrete slab installation as described below:

   Frequency: A minimum of two inserts from every 200 foot track section of each wall anchor insert installation (a minimum of two inserts for every 100 inserts installed) shall be tested. One anchor insert will be the initial test and the second anchor insert is required if the first anchor insert fails.

   a.) Randomly select materials for testing during the installation for a true representation of the work unless otherwise directed by Sound Transit.

   b.) Notify Sound Transit 24 hours in advance of the location and time of anchor insert testing.

   c.) Submit the test results to Sound Transit. Retain copies for submission with project record documents.

2. Restrained Pull-Out Test:

   Test Method:

   a.) Place a 5-inch by 5-inch by 1/2-inch steel plate with a hole in the center 1/4 inch larger in diameter than the insert top collar over the insert and clear of the collar.

   b.) Install an anchor bolt in the insert and apply an upward vertical load of 20,000 pounds bearing against the steel plate.

   c.) Hold the load for 1 minute, and then release the load.

   d.) Acceptance Criteria: No evidence of bolt to insert failure or slippage or cracking of epoxy grout or failure of the bond between the insert and epoxy grout.

3. Unrestrained Pull-Out Test:

   Test Method:

   a.) Install an anchor bolt in the insert and apply an upward vertical load of 8,000 pounds to the bolt in such a manner that no vertical load is applied to the concrete block and not the cementitious grout within a radius of 6 inches from the centerline of the insert.

   b.) Hold the load for 1 minute, and then release the load.

   c.) Acceptance Criteria: No evidence of slippage or cracking of concrete or failure of bond between the insert and plinth concrete or epoxy grout.

4. Torsion Test:

   Test Method:
a.) Apply 400-foot-pounds of torque to an anchor bolt installed with at least 1-inch thread engagement in the anchor insert but not threaded to the bottom of the insert.

b.) Acceptance Criteria: No evidence of failure of the bond between the insert and surrounding epoxy grout.

C. Should the first test insert fail to pass the specified tests, test the second insert from the same test length.

1. 100 percent of the remaining insert lot shall be rejected. If the second insert fails to pass the specified tests.

2. Perform additional tests as specified above and other tests as required on concrete and other materials associated with insert installation to determine the limits and cause of the defective installation.

3. Do not proceed with further anchor insert installation until the cause of failure have been determined and a modified procedure ensuring satisfactory installation has been approved by Sound Transit.

4. Submit revised procedures and materials for resetting inserts for Sound Transit’s approval.

D. Final Acceptance of Floating Slab Track:

1. The final track structure, at the discretion of Sound Transit, shall be free of any visible surface cracks to the floating slabs and the trench caps; free of chipped floating slab or trench cap concrete at all corners and edges; free of inappropriate installation of the side brackets and the connecting components on the floating slab and at the tunnel vertical walls and free of inappropriate installation of the end separation pads between the adjacent floating slab surfaces.

2. Floating slabs and their components found with any of the above deficiencies shall be repaired or removed and replaced in kind at no cost to Sound Transit.

3. Floating slab cracks deemed un-repairable will be cracks:

   a. Longer than 12 inches from originating point

   b. Cracks projecting out more than 4 inches from any anchor insert location

   c. Cracks of a magnitude to be considered greater than “hairline” cracks showing separation or opening of concrete.

4. Deficiencies as to floating slab cracks at the discretion of Sound Transit to be deemed repairable will be repaired in accordance with Article 3.10 in this Section.

5. Floating slabs with deficiencies as chipped corners and edges at the discretion of Sound Transit to be deemed un-repairable will be replaced.

6. Un-repairable chips will be of a size exceeding 1 inch deep along the edge and 4 inches long. Floating slabs with chips exposing reinforcing bar shall be replaced.
7. Deficiencies as to floating slab chips at the discretion of Sound Transit to be deemed repairable will be repaired in accordance with Article 3.10 in this Section.

8. The floating slab arrangement and alignment shall be installed to generate direct fixation track to the alignment tolerances specified for direct fixation track with the minimum of direct fixation fastener lateral adjustment and application of vertical corrective shimming beneath the direct fixation fasteners.

END OF SECTION