



## **IGGA Guide Specification: Dowel Bar Retrofit (DBR)**

### **Introduction**

This standard developed by the International Grooving and Grinding Association (IGGA) specifies the procedures for construction of dowel bar retrofit on existing Portland Cement Concrete roadways. The user of this standard shall be responsible to ensure that all local safety, health and environmental standards are made a part of the specifications.

The user of this standard accepts ALL responsibility for decisions made as a result of its use. The International Grooving and Grinding Association, its Officers, Board of Directors and staff are absolved of any responsibility for any decisions made as a result of your use. Use of this standard implies acceptance of the terms of use.



## **Guide Specification: Dowel Bar Retrofit (DBR)**

**Publication Date: June 1, 2011**

### **SCOPE**

Dowel bar retrofit (DBR) consists of installing epoxy-coated, smooth, round dowel bars into existing concrete pavement across transverse joints and/or cracks. Slots are cut using diamond-tipped saw blades; the concrete is removed using lightweight jackhammers. The dowel assemblies are placed in the slots across the joints or crack and anchored into the existing pavement with non-shrink concrete backfill material.

### **Materials**

**DOWELS** -- Dowels shall be smooth, round epoxy-coated steel conforming to the requirements of ASTM A 615/615M grade 40 or 60 (300 or 420) and the details shown in the plans and specifications.

Dowels shall be smooth, round bars that are sawn, not sheared, at the factory. Dowels shall be free from burrs or other deformations detrimental to free movement of the bars in the concrete.

**BOND BREAKER** -- Dowels shall be entirely coated with a bond breaking compound such as white pigmented curing compound or other approved bond breaker material. The bond breaker shall be applied at the manufacturing facility. Do not apply bond breaker while the dowel bar assemblies are in place within the pavement section.

**EXPANSION CAPS** -- The dowel bars shall have tight fitting end caps made of nonmetallic non-organic material that allows for 0.25 inch bar movement at each end of the bar.

**DOWEL BAR SUPPORT CHAIRS** -- Chair devices for supporting the dowel bars shall be either epoxy coated steel in accordance with ASTM Designation A 884/A 884M or shall be fabricated of commercial quality nonmetallic, non-organic material. The chairs shall be designed to press securely against the slot face to firmly hold the dowels in the proper position while the backfill material is placed and consolidated.

**FOAM CORE INSERT** --- The foam core board fill material shall be 0.375 inch thick (minimum), rigid styrofoam or closed cell foam faced with poster board material or plastic faced material on each side.



**CAULKING FILLER** -- Caulking filler used for sealing the existing joint or crack at the bottom and sides of the slot shall be any commercial caulk designed as a concrete sealant that is compatible with the patch material being used.

**CONCRETE BACKFILL MATERIAL** -- The Portland cement concrete pavement that is removed to install the dowel bar assemblies shall be replaced with one of the following approved patching products: Five Star Highway Patch, AHT DB Retrofit Mortar, CTS Rapid Set Cement or approved equal.

The material manufacturer shall provide annual certification to the engineer that the neat material meets the following standard:

1. Compressive Strength, 3-hour minimum at 3000 psi and 24-hour minimum at 5000 psi (ASTM C-109)
2. Scaling, with a visual rating of 2 or less (ASTM C-672)
3. Shrinkage, 4 days, 0.13 percent maximum (ASTM C-157)
4. Durability Factor, 90 percent minimum at the end of 300 freeze-thaw cycles, (ASTM C 666A)
5. Bond Strength of 1000 psi in 24 hours (ASTM C-882)

The contractor's supplier shall provide documentation to the engineer 30 days prior to project production that the material meets the above requirements.

The contractor's supplier of the patching product shall provide a concrete mix design, including all additives, to meet a minimum compressive strength of 3000 psi in 3 hours and 5000 psi in 24 hours (ASTM C-39). The mix shall meet the shrinkage requirement of 4 days, 0.13 percent maximum (ASTM C-157). The mix shall develop bond strength of 1000 psi in 24 hours (ASTM C-882). The mix design shall be developed using local materials that will be used on the project.

The fine portion of the aggregate shall meet local requirements for concrete sand. The coarse portion of the aggregate shall meet local concrete aggregate quality requirements and have a gradation of 100 percent passing the 3/8 sieve, 0-15 percent passing the #4 sieve, 0-5 percent passing the #8 sieve and a maximum of 1.0 percent passing the #200 sieve. The proposed mix design shall be provided to the engineer 30 days prior to starting operations. A trial batch shall be produced in the field no less than 3 days prior to starting production operations. The trial batch shall be produced utilizing the equipment and procedures that will be utilized on the project. The material shall be tested to ensure it meets contract requirements.

During production operations, the engineer shall test the backfill material every 250 bars placed to verify that the minimum compressive strength requirements are being achieved.



## **Pre-Construction Requirements**

**PRE-CONSTRUCTION TRAINING** -- Prior to construction, all supervisory personnel involved in the dowel retrofit installation shall meet with the engineer to discuss methods and procedures to complete all phases of the dowel retrofit work. Attendance at the meeting is mandatory for the project superintendent, construction foreman, subcontractors involved in retrofit operations, phase lead men and any personnel representing the awarding agency involved in the inspection and acceptance of the dowel retrofit work. The pre-construction conference will be conducted at a mutually agreed upon time at a facility provided by the contractor located near the construction site.

The above mentioned personnel shall attend a 2-hour training class on dowel bar retrofit placement techniques as a part of the pre-construction conference. This training class time shall be in addition to the conference time. The class shall be no more than 2 weeks prior to the placement of dowels and will be held during normal working hours. Selection of the instructor shall be as agreed to by the engineer and the contractor.

The mandatory training class may be waived if the contractor provides documentation from another agency stating that the contractor and the proposed personnel have satisfactorily completed similar dowel bar retrofit projects. State personnel will be waived if they have prior dowel bar retrofit inspection experience. The use of this training is encouraged as a refresher even for those with some prior experience.

**TEST SECTION** -- The contractor shall construct a test section that consists of concrete sawing, concrete removal and placement of dowel bars and backfill material at a location directed by the engineer prior to the start of major operations. The test section will be one lane width and 20 joints in length. Three full-depth cores, at least 4 inches in diameter, will be taken as directed by the engineer, to determine the completeness of the slot removal, dowel bar installation and the backfill consolidation operations. Upon approval from the engineer, the contractor may begin production operations and shall proceed on a performance basis.

If the test section does not conform to the plans and specifications, the contractor will be required to construct an additional test section to demonstrate the contractor's ability to install the retrofit dowels in a fashion that meets the requirements of the plans and specifications.

## **Construction Requirements**

The contractor shall install the dowel bars in the existing Portland cement concrete pavement as shown in the plans and according to the following requirements:

**SAW CUTTING** -- Two saw cuts shall be made in the pavement to outline the longitudinal sides of each dowel bar slot. The slots shall be sawn to a depth and length that allows the dowel to be placed at mid-depth in the pavement slab. The slots shall be parallel to the top of



the pavement within +/-0.25 inch in 18 inches, parallel to the other slots within +/- 0.125 inch in 18 inches and parallel to the roadway centerline +/- 0.50 inch in 18 inches.

The contractor shall employ saws equipped with gang mounted diamond blades and shall be capable of cutting a minimum of three slots simultaneously – three in each wheel path. Pick up and remove water and paste residue from the pavement surface immediately by means of a vacuum attachment on the sawing equipment. Skewed joints or cracks may require slots longer than the length specified in the plans. No additional compensation shall be made for the additional sawing or any component of the dowel bar retrofit beyond the limits shown on the plans required to ensure that at least 7 inches of dowel bar is placed on each side of the joint or crack. Traffic will be limited to five days on sawn slots prior to completing the retrofit operation. For smaller projects (100 bars or less), a slot saw may not be feasible. Walk-behind saws may be allowed as long as a template is used to ensure the slot locations are within the specified tolerances.

Vacuum equipment shall be utilized in conjunction with the sawing operation to ensure saw residue does not enter closed drainage systems or adjacent lanes carrying traffic.

**CONCRETE REMOVAL** -- Jackhammers used to remove concrete remaining between the saw cuts shall not be larger than 30 pounds. If the concrete removal operations cause damage to the pavement that is to remain, the concrete removal operation shall be discontinued and shall not resume until the contractor has taken corrective measures. Pavement damaged during concrete removal operations shall be repaired or replaced at the contractor's expense.

During concrete removal operations, a small brush hammer may be required to produce a flat, level surface within the slot so the bar can be placed in the proper location allowing the backfill to be consolidated under the dowel bar. Debris from the removal operations shall be removed daily and disposed of in a method and at a location approved by the engineer.

Operations shall be scheduled so that all concrete removed during any work shift shall be replaced with dowel bars and backfill material prior to the time the lane is opened to traffic.

**SLOT CLEANING AND PREPARATION** --- All exposed surfaces in the dowel bar slot shall be sandblasted to remove saw slurry and debris. Waterblasting is an acceptable alternative to the sandblasting once the contractor demonstrates acceptable results can be obtained. Pressures shall be maintained in such a manner that the surface is thoroughly cleaned without damaging the surface. Care shall be taken to insure the waterblasting has removed all saw slurry from the kerf area. After sandblasting/waterblasting, the slot shall be further cleaned by blowing moisture-free compressed air, having a minimum pressure of 150 psi, into it to remove any leftover dust, residue or debris.



**SEALING JOINTS AND CRACKS IN SLOT** -- The contractor shall seal the existing joint and/or cracks at the bottom and the sides of the dowel slot with an approved caulking filler to prevent any of the backfill material from entering these areas. The surface to receive the caulk shall be clean and free of moisture. The caulking filler shall not extend beyond 0.375 inch of each side of the existing joint or crack.

**PLACING DOWEL ASSEMBLY IN SLOT** -- The contractor shall use good construction practices to prevent contamination of the cleaned slot while placing dowel assemblies in the slot, thereby limiting the potential for bond loss between the repair material and existing pavement. The dowel bar support chairs shall provide a minimum of 0.50 inch clearance between the bottom of the bar and the bottom of the slot. Dowels shall be placed within 0.50 inch tolerance of the depth shown in the plans. Dowels shall be centered at the transverse joint or crack so that at least 7 inches of the dowel extends into the adjacent panel. The chairs shall hold the dowel assembly securely in place during placement of the backfill material.

The foam core board insert shall be placed at the middle of the bar and 2 to 2.5 inches below the surface of the concrete pavement. The insert shall be sized so that it fits tightly against the edges of the slot and covers the existing transverse joint or crack and must be capable of remaining vertical during backfill placement operations. The joint or crack above the insert shall be re-established as soon as the backfill material has hardened sufficiently to allow sawing. In no case shall it be sawed later than 8 hours after backfill placement.

**MIXING AND PLACING BACKFILL MATERIAL** -- The contractor shall thoroughly moisten all surfaces of the slot immediately prior to filling with backfill material. Care shall be taken to prevent standing water in the slot.

Fast-setting backfill material shall be mixed in accordance with the manufacturer's recommendations. The mixing operation shall be monitored to ensure that backfill material remains in a fresh condition and is used before it has taken an initial set. Under no circumstances will partially set material be allowed to be re-tempered with additional water.

The contractor shall fill each prepared slot with the fast-setting backfill material. Care must be taken to ensure that the foam core insert remains upright over the existing joint or crack during the backfill operation. The backfill material shall be vibrated with a small (1 inch diameter) hand-held vibrator capable of thoroughly consolidating the backfill material into the slot around the dowel bars and support chairs.

When diamond grinding is a part of the contract, the surface of the backfill material shall be left 0.25 inch higher than the existing concrete surface. When diamond grinding is not part of the contract, the backfill material shall be troweled level with the concrete surface. The final surface shall be cured within 60 seconds of placement in accordance with backfill manufacturer's recommendation.



**TEMPORARY BACKFILL** -- If dowel bar retrofit is constructed during limited lane closures, the contractor shall have temporary backfill available on site. A sufficient standby quantity of asphalt concrete shall be provided at the project site for placement as temporary backfill in slots where the fast setting backfill cannot be placed.

**OPENING TO TRAFFIC** -- Unless otherwise permitted in writing by the engineer, traffic shall not be permitted on dowel-retrofitted pavement until the fast setting backfill attains:

- (1) a compressive strength of 3000 psi or greater per ASTM C109, or
- (2) a flexural strength of 350 psi or greater.

**DOWEL PLACEMENT ALIGNMENT ASSURANCE** -- The contractor will utilize coring to confirm dowel placement and proper consolidation. The 4-inch diameter cores shall be identified by the contractor with a location description and submitted to the engineer for inspection.

After removal of the cores, core hole voids shall be cleaned and filled with fast setting backfill material used in the dowel retrofit operation. The backfill material shall be troweled, while still plastic, to match the adjacent pavement surface. The backfill shall not evidence any depressions or surplus material above the level surface of the existing pavement.

Water from the coring operation will not be allowed to flow across lanes occupied by public traffic or flow into closed drainage facilities.

The contractor shall randomly check dowel positioning by coring. Each day's retrofitting will be checked by the contractor within two calendar days by performing one test for each 600 bars or the day's production, whichever is less. One test shall consist of drilling two cores, one on each end of a dowel bar to expose both ends and allow measurement for proper alignment. If the dowels are located incorrectly or air voids exist around the dowel bars, additional cores will be taken, as directed by the engineer, to determine the severity.

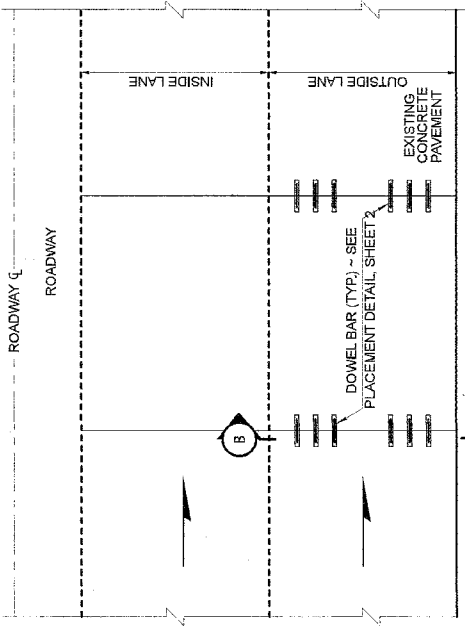
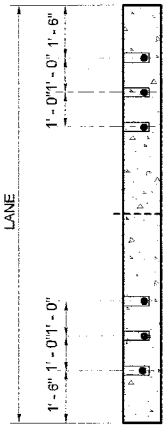
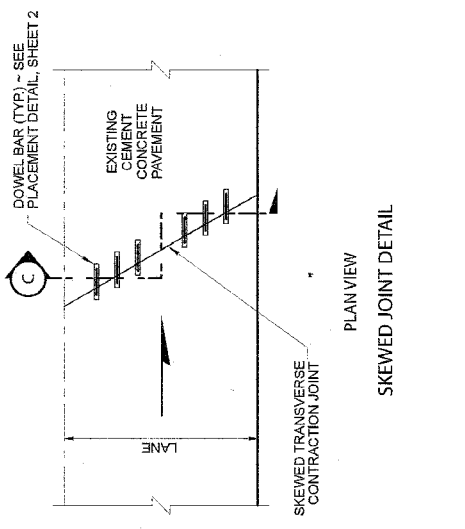
Dowel retrofitting operations will be suspended if dowels are installed improperly. Dowel retrofitting operations will not resume until the contractor has demonstrated to the engineer that the problem which caused the improper dowel positioning or air voids has been corrected. Any individual dowel bar retrofit not functioning or damaged shall be replaced at the expense of the contractor.

When the coring operations have shown no problems with the contractor's placement operations for five tests, the engineer may decrease the frequency of core testing to each 1000 bars.

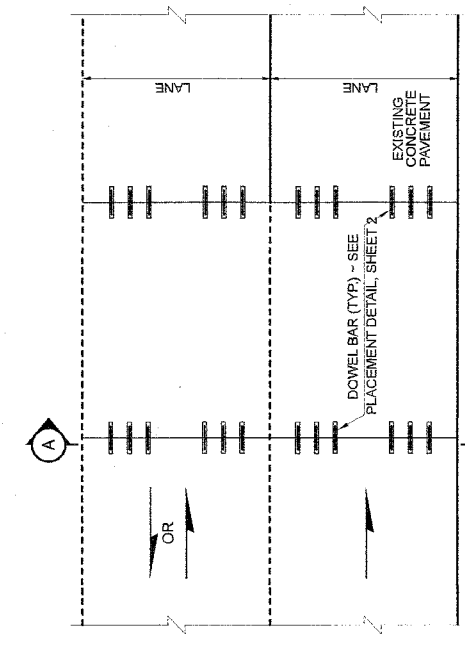
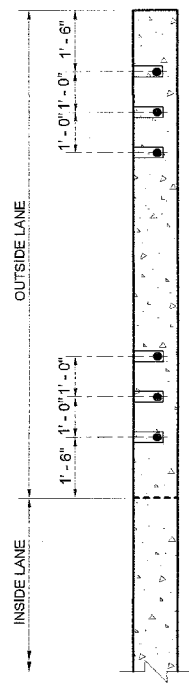
**MEASUREMENT AND PAYMENT** --- Dowel bar retrofit will be measured by each dowel bar assembly installed and accepted. This includes dowel bars constructed in the test section that



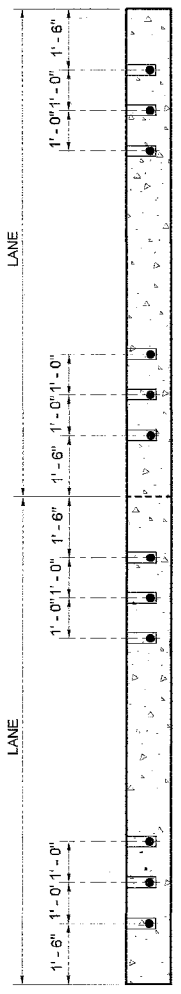
are found to be acceptable. The contract unit price paid for each dowel assembly shall include full compensation for furnishing all labor, equipment, materials, tools and incidentals involved in placing dowel bar retrofits complete in place, including temporary backfill operations, proper pick up and handling of saw slurry, core testing and the pre-construction conference and training costs.



PLAN VIEW  
DOWEL BAR RETROFIT FOR ONE LANE  
DIVIDED HIGHWAY (ONE WAY TRAFFIC)



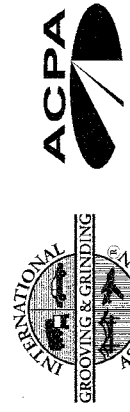
PLAN VIEW  
DOWEL BAR RETROFIT  
FOR TWO LANE DIVIDED HIGHWAY (ONE WAY TRAFFIC)  
FOR EACH LANE IN UNDIVIDED HIGHWAY (TWO WAY TRAFFIC)



**DOWEL BAR RETROFIT FOR CONCRETE PAVEMENT**

SHEET 1 OF 2 SHEETS  
04-21-11

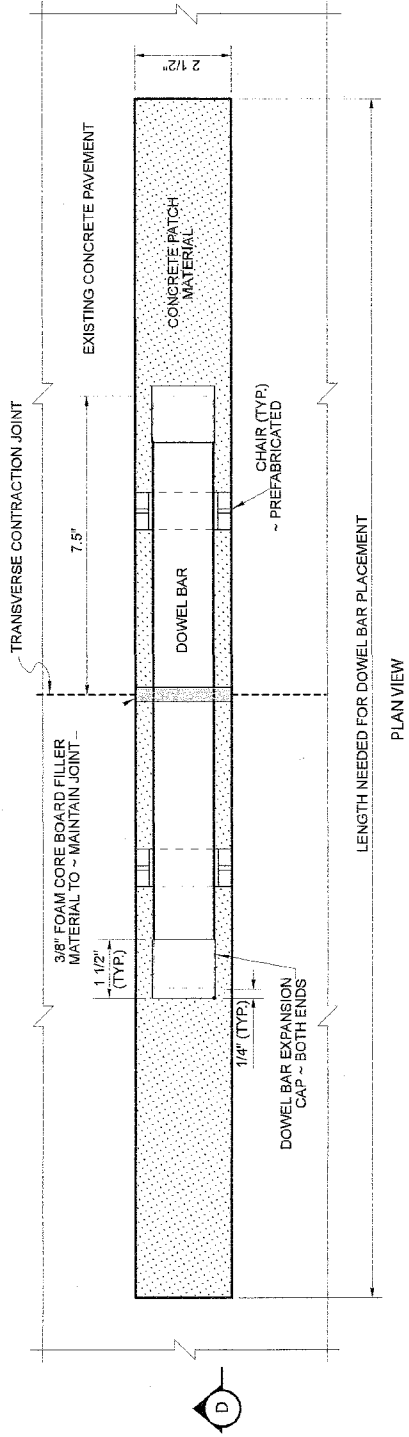
ADAPTED BY THE INTERNATIONAL GROOVING & GRINDING ASSOCIATION (IGGA) AND THE AMERICAN CONCRETE PAVEMENT ASSOCIATION FROM WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) STANDARD PLAN A-60.20-01, DOWEL BAR RETROFIT FOR CEMENT CONCRETE PAVEMENT, 08-11-09; PERMISSION TO USE AND MODIFY DRAWING PROVIDED COURTESY OF WSDOT.



# DOWEL BAR RETROFIT FOR CONCRETE PAVEMENT

SHEET 2 OF 2 SHEETS  
04-21-11

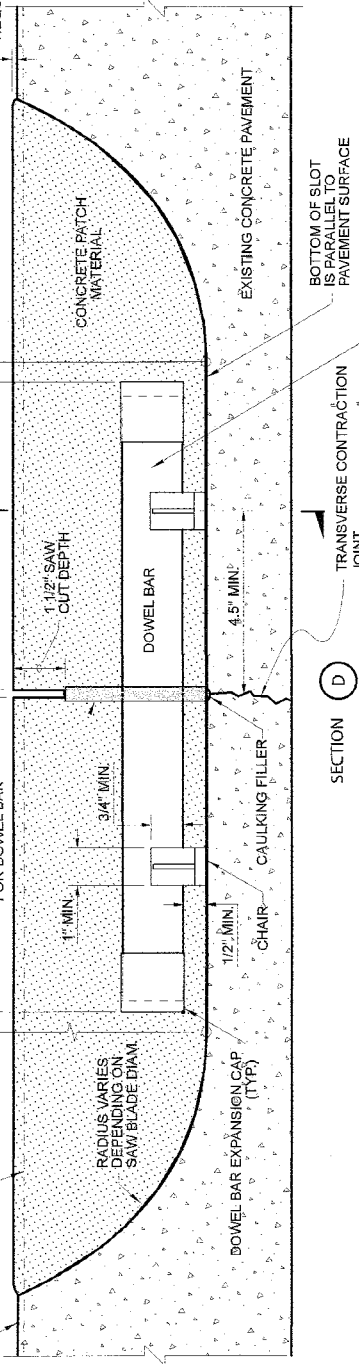
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1/8" DEPTH OF CONCRETE PATCH MATERIAL ABOVE EXISTING CONCRETE SURFACE FOR PROJECTS TO BE DIAMOND GROUND; MAKE FLUSH IF DIAMOND GRINDING IS NOT REQUIRED

3/16" MIN. TO 5/16" MAX. SAW CUT AFTER CONCRETE PATCH MATERIAL HAS SET  
3/8" FOAM CORE BOARD ~ DRILL 1 1/2" DIAM. HOLE FOR DOWEL BAR

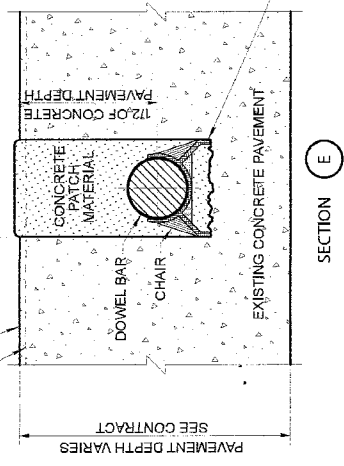
TOP OF PAVEMENT AFTER GRINDING (NOT INCLUDED IN BID ITEM)  
TOP OF EXISTING CONCRETE PAVEMENT



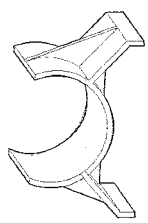
DOWEL BAR PLACEMENT DETAIL

RECOMMENDED DOWEL DIAMETER	PAVEMENT THICKNESS	DOWEL DIAMETER
5/8 inches	8.5 to 10.5 inches	1 inch
1/2 inches	≥ 11 inches	1 1/4 inches
3/4 inches	≥ 11 inches	1 1/2 inches

TOP OF EXISTING CONCRETE PAVEMENT  
TOP OF PAVEMENT AFTER GRINDING (NOT INCLUDED IN BID ITEM)



DOWEL BAR PLACEMENT DETAIL



CHAIR DETAIL

CHAIR TO REST PARALLEL TO SURFACE