How To Construct A Fractured Core For Gel Testing

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How to Construct a Fractured Core for Gel Testing

- 1. Put factory smooth sides together (on the inside)
- 2. Add shims
 - a. 1mm core: use 2 shims if using 0.5mm shims.
 - b. 2mm core: use 4 shims if using 0.5mm shims.
 - c. Insert x# of shims and add a "C" clamp making sure the clamp is directly over the shim. *DO this for BOTH ends (injection/outlet) of the core.



d. Repeat step 2c for the length of the core. Use enough shims to maintain a constant fracture width. For a 4' core place in $\frac{1}{4}$ increments down the length of the core.



REMEMBER: WHERE EVER YOU HAVE A SHIM YOU NEED A CLAMP!!!

3. NYLON MESH

a. Add 1" - 2" nylon mesh strips along the length of the core - see drawing below.



- b. Mix 1:1 parts (A & B) of 5 min epoxy (e.g.: Devcon "5 min." epoxy).
- c. VERY gently coat mesh strips with epoxy: you want to be gentle because it does not take much pressure for the nylon strips to adhere to the core too much pressure will push the epoxy through the mesh and into the fracture. **BE <u>VERY</u> CAREFUL WHEN EPOXYING!!! You do NOT want to get epoxy inside the fracture** Let epoxy cure completely.



- d. Remove clamps and shims "B", "C" and "D".
- e. Flip core over.
- f. Insert shims and clamps "B", "C" and "D".
- g. Repeat steps 3a 3d.
- h. Place a long strip(s) of nylon mesh down the length of the core (for a 4' core you will need 2 strips for a 2' core you will need only 1).
 Make sure the strip(s) go the length of the core. If there are any gaps, they can be filled in using smaller pieces of nylon mesh.

 Tack down the strips, with 5 minute epoxy, on the far ends of the core. **BE <u>VERY</u> CAREFUL NOT TO DRIP EXPOXY DOWN THE SIDES OR FACE OF THE CORE**



The edge of the nylon should be parallel to the edge of the core

j. Once the tacked down ends have cured, make up more of the 5 minute epoxy and epoxy the nylon strip(s) all the way down the length of the core. START FROM THE FAR ENDS AND MOVE TOWARDS THE CENTER OF THE CORE. Again, be <u>VERY</u> careful not drip epoxy down the sides of the core.



- k. Let cure. Once epoxy is cured add a second coat of epoxy.
- I. Flip core over and repeat steps 3h 3j.
- m. Remove clamps and shims "A" and "E".

4. MATRIX TAPS (if using in experiment)

a. Choose which end of the core you would like your matrix taps to go on. HINTS: If you have epoxy that has dripped over the edge from when you epoxied the nylon mesh, choose the end that 1) has the least amount of epoxy along the sides of the core, or 2) has the most epoxy on the face of the core, for your outlet end. b. For the matrix taps use the polycarbonate squares with the SMALLER sized holes. (The squares with the larger holes will go on the inlet and outlet faces).



Front Face

Back Face

- c. Add a generous bead of epoxy to the ledge of the backside of the polycarbonate square. ***BE CAREFULL: <u>ONLY</u> put epoxy on the ledge! Do NOT put epoxy anywhere else***
- d. Add a polycarbonate square to the side of the core <u>MAKE SURE</u> <u>THE EDGE OF THE SQUARE IS FLUSH WITH THE FACE OF</u> <u>THE CORE</u>. This end of the core is now your matrix/outlet end.



*HINT: when adding the matrix tap, flip core onto its side so that you are looking down upon the side you are working on - see below.



 e. Any epoxy extruding from the polycarbonate square you will want to smooth over onto the fracture face of the outlet side. DO
 NOT GET EPOXY IN FRACTURE!!! Use only a thin coating of the 5min epoxy on the outlet face. THICKER IS <u>NOT</u> BETTER!



f. Epoxy the length of the core starting from the injection end. Again use only a thin coat of the 5min epoxy. You are only sealing the core from the casting epoxy. THICKER IS <u>NOT</u> BETTER!



- g. Let cure.
- h. Repeat steps 4c 4g for the other side of the core
- i. For the matrix taps only use the nylon fittings. If using 4" PVC piping you can add the fittings once the polycarbonate squares are set. If using 3" PVC piping you will have to add the fittings once the core is in the pipe.

5. INLET AND OUTLET TAPS

- a. Use the polycarbonate squares with the LARGE holes.
- b. Screw the large o-ring metal fittings into the polycarbonate square.
- c. Flip the core to the vertical position make sure it can rest against a stationary object.
- d. Add a generous bead of epoxy to the ledge on the backside of the polycarbonate square - MAKE SURE YOU ONLY GET EPOXY ALONG THE LEDGE!
- e. Add the polycarbonate square to the outlet face of the core.
- f. Once epoxy has set, flip over and repeat steps 5c 5d on the inlet face.



6. PRESSURE TAPS

- a. Fracture side up, measure the length of the core (from the start of the rock to the end of the rock).
- b. Take the length of the core and divide by the number of pressure taps you want + 1. (See equation below)

- c. Measure this number starting from both ends of the core. Depending on how many taps you desire, will depend on how many intervals you will mark. Mark your intervals with a line.
- d. For a 4' core, with 4 pressure taps: mark a line at 24.4cm and 48.8cm from the right hand side (beginning where the rock starts) and then repeat the measurement starting from the left hand side.



The black lines are indicators for where the pressure taps will go

e. Place fittings in the polycarbonate rectangles **<u>BEFORE</u>** epoxying.



Bottom of rectangle - scuffed with sander

f. Dip the bottom of the polycarbonate rectangle into the epoxy and place it on the core so that the length of the rectangle is parallel to the length of the core.

BE SURE THE CENTER OF YOUR TAP/FITTING IS ON THE CENTER OF YOUR FRACTURE



- g. After placing fracture taps onto the core, monitor them until the epoxy has started to cure. The polycarbonate squares have been known to slide off center as the epoxy heats up from curing.
- h. Let epoxy cure completely around 12 hours is best.
- i. Drill out the epoxy in the polycarbonate rectangles drill down until you can see the fracture width clearly; a few mm into the fracture is a good depth. When drilling start at the pressure tap closest to the inlet and move down the core, in order, until you reach the pressure tap closest to the outlet.
- j. Clean out taps and fracture with compressed air (start cleaning at the inlet and end at the outlet).
- k. Replace fittings.

IF USING 3" PVC USE THE METAL FITTINGS ***IF USING 4" PVC USE THE NYLON FITTINGS***

- 7. PVC PIPE ALL REFERENCES TO PVC IMPLIES SCHEDULE 40 PVC
 - a. Thoroughly clean the outside of the PVC pipe with soap and water, and let dry.
 - b. Prepare your end caps: You'll line up the end caps with the manufacturers label on the pipe. <u>DO NOT</u> put the caps on the pipe at this time.

For **4" PVC the end caps will have reference lines every 90° in permanent marker. You'll want to line up 1 of the lines with the manufacturers label (this will be where the top of your fracture is). The remaining 3 lines represent the following: The 2 lines 90° from the top line are where your matrix tap will go, the last line will be the bottom of your core (which you will reference when cutting the core open).

For **3" PVC your matrix tap reference will be the manufacturing seams of the cap. The top of your fracture reference will be the cap's manufacturers mark, again it will be centered with the center of the manufactures line on the PVC pipe.

c. Before attaching the end cap to the pipe add a **thin** coat of epoxy $\frac{1}{2}$ way up the INSIDE of the cap.



fittings fit through cap

d. Put the cap on the end of the PVC pipe, make sure it is ALL the way on the pipe (press the cap on as far as it will go, and then, if necessary, lightly tap the cap with the hammer. DON'T FORGET that your reference line on your cap needs to be centered with the manufacturers reference line on the pipe.



View of the PVC pipe with the cap on, if you were looking directly down upon it. Notice the reference line is centered in the middle of the manufacturers label.

- e. Rest PVC vertically (with cap on top) against a stationary surface to let epoxy cure.
- f. Once epoxy has cured, flip the PVC pipe 180° (so that the cap is now on the bottom).
- g. Place a bead of epoxy along the seam where the pipe and cap meet, and smooth with fingers. Let set (in the vertical position) until epoxy has completely cured.



Bead of epoxy

Smoothing epoxy with finger

8. MEASURING TAP HOLES FOR PVC PIPE

- a. Place PVC pipe (with cap) on a horizontal surface.
- b. Slide core into the PVC the outlet/matrix end should be put into the core first.
- c. Put the core all the way in the PVC so that the outlet fitting is through the end of the end cap.



d. Make a mark around the fitting where it meets the cap or remember where they meet.



- e. Remove the core from the PVC pipe.
- f. Place the core in front of the PVC pipe.
- g. Line up the marker line on the outlet fitting with the flat top of the outlet cap.



h. Mark the center of each pressure tap along the manufacturers line on the PVC pipe.



- i. Rotate core 90° (so that you can mark a matrix tap).
- j. Repeat step 8g.
- k. Mark the center of the matrix tap on the reference line/seam.
- I. Rotate core 180° (for the other matrix tap).
- m. Repeat steps 8j 8k.

9. MILLING PVC PIPE

- a. Mill out the holes you marked on the PVC pipe, and mill out holes between the pressure tap holes so you can pour epoxy into the holes. You want your matrix holes to be big enough that you can put your fittings in and tighten the fittings with a wrench. You want your pour/pressure tap holes big enough that you can pour epoxy into them without having the epoxy drip down the side of the core, and big enough that you can put the fittings on.
- b. Clean the rough edges.



10. PUTTING THE CORE IN THE PVC PIPE

- a. Repeat steps 8a 8c.
- b. Check that you are able to see the matrix tap holes and pressure tap holes through the holes that you milled out.
- c. Place the inlet cap onto the open end of the PVC pipe, making sure that the inlet fitting goes through the drilled hole in the cap.
 DO NOT PUT EPOXY ON OR IN THE CAP at this time Hammer

the inlet cap on so that the cap is on tight and you can NOT rotate the core inside the pipe.

- d. Place the core so it is in the vertical position (matrix side up), and have it lean on a stationary object.
- e. Make some 5 minute epoxy and epoxy in the hole where the outlet fitting and the end cap intersect.



- f. Repeat step 10e (as many times as need) once the epoxy has cured. The epoxy should be on the surface of the cap.
- g. Repeat step 7g for the inlet end of PVC.
- h. Flip core 180° and repeat steps 10e 10f.

i. Place tubing and caps together as shown below. The length of your tube only needs to be a few inches long. These will be used for your pressure taps and your matrix taps.



j. Insert the tubing and cap assembly into the pressure tap fittings and matrix taps.



k. Place packing tape over the <u>matrix</u> holes on the PVC pipe. If done correctly, this will keep the epoxy from leaking out through the holes.



11. CASTING THE CORE

- a. Place core upon stilts, sections of H channel work very well.
- b. Rotate the core so that the pouring/pressure tap holes are 45° from the top.



- c. Mix "Sikadur® 35, Hi-Mod LV" epoxy and sand. 2 parts A : 1 part B, add sand so that epoxy is not runny, but still drips.
- d. Pour epoxy into pour holes.



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- e. Let epoxy cure completely (approximately 5 hours).
- f. Repeat steps 11c 11e until the epoxy is level with the bottom of the pour holes.
- g. Rotate core90° and repeat steps 11b 11f.
- h. Lift the core so that one of the outlet ends is up on stilts while the opposite end is on the table (holes still at a 45° angle). See below.



- i. Pour in epoxy and let cure completely.
- j. Repeat steps 11h 11i for the opposite end.



- k. Rotate core 90° and repeat steps 11h 11j.
- I. Rotate the core so that it is vertical (or as close to vertical as possible).
- m. Add epoxy mixture to the hole closest to the floor only. Fill so that mixture is level with the bottom of the hole. Let epoxy cure completely.



- n. Flip core 180° and repeat Step 11n.
- Place core on table in the horizontal position with the pour holes facing upward, add epoxy mixture until core is completely full (epoxy is at the surface of the core).
- p. Let epoxy cure for one day.

12. PORE VOLUME

- a. Weigh core dry weight.
- b. Saturate the core.
- c. Weigh the core saturated weight.
- d. The difference between the dry weight and the saturated weight is the pore volume.

KEY



THINGS TO REMEMBER

- 1. Protect your workstation by putting wax paper under your cores. The epoxy does NOT stick to the wax paper.
- 2. ALWAYS wear gloves while epoxying.
- 3. Make sure you have on protective eye gear (safety glasses) and closed toe shoes while in the lab.

PARTS AND PIECES

The following are examples of what products are used when constructing a core for gel testing. These are just examples of what has been used, other similar products may be used instead.

NYLON MESH: Monofilament Cloth - Nylon Mesh Size: 149 microns

5 MINUTE EPOXY: Devcon "5 minute" Epoxy
Part A: 5 minute Epoxy
Part B: Hardener

CASTING EPOXY: Sikadur® 35, Hi-Mod LV Epoxy

Part A: Sikadur® 35, Hi-Mod LV/LVLPL This is a high modulus, low-viscosity, high strength, epoxy adhesive.

Part B: Sikadur® 35, Hi-Mod LV This is a high modulus, low viscosity, high strength, epoxy grouting/sealing/binder adhesive.

SAND: Sandbox sand for children's sandboxes

FITTINGS: Swagelok "O Seal Straight Thread Connector" - size is dependent upon experimenter's needs.



PHOTOS FROM AMAURY MARIN



















































