CONSTRUCTION MONITORING

WHAT TO LOOK OUT FOR

Construction monitoring isn't a course taught at university or polytechnics, yet it plays a vital role in ensuring the project is completed properly. Engineering New Zealand and the Engineering General Practitioners Group have been working on a general guideline of what to do and what to look out for when going to site.

HEALTH AND SAFETY

If you see something that is a health and safety concern, you should notify the foreperson. If it is safe to do so, take photos of the problem. When you return to the office, discuss this with your supervisor.

Even though this is not a legal requirement under the Health and Safety at Work Act 2015, it is your obligation under the Code of Ethical Conduct as a member of Engineering New Zealand to take reasonable steps to safeguard health and safety and to report adverse consequences.

BEFORE GOING ON-SITE

1. Identify which stage of construction you're inspecting.
2. Look at the plans, identify and mark on drawings what you need to check while on-site.
3. If you're checking someone else's work, always go and ask them what the critical parts are after you have worked through it. There may be things you miss during your check, for example, how close to a surcharge (like a house, driveway or road) the contractor is cutting for a retaining wall. If the originating engineer isn't in the office, check your assumptions with a senior engineer.
4. Always check your PPE, including sunscreen and sunglasses, is in the car. When looking at white surfaces (like polystyrene pods), you can quickly get sore eyes/snow blindness. When speaking to the foreman before going to the site, ask if you need any particular PPE (e.g. gloves).
5. Take a good torch; often, the one on your phone isn't sufficient when you need to be looking in attics, down holes, into pipes etc.
6. Make sure you have a construction monitoring template that you're filling in. If your office doesn't have one, you can download one for free from the Engineering New Zealand website, along with an example of how to fill them in properly.

ON-SITE

Arriving on-site

1. Before entering the site, stop and take an overall photo of the work. The picture helps identify the project in your photo roll and shows the general state of construction, the weather, number of people working etc.
2. Stop and think: Why am I here? Has some work already been completed and covered up? Is the site safe to enter? Regardless of whether other people are on-site, it may not be safe for *you* to enter.
3. If a machine is working, you must ensure the operator has seen you before approaching the work.
4. Call the foreman from the site boundary if necessary and ensure that you have completed any sign-in requirements. Doing so helps demonstrate to the contractor that you expect them to complete work correctly.
5. Look at the job site. Is it clean and tidy? If it's messy, it's an indicator the contractor isn't well organised.

While on-site

Working with the contractor

1. You must work with the contractor to deliver the best solution. Often, the contractor can offer sound advice on building things practically. Always listen.
2. Just because something works on paper doesn't mean it can be constructed. Listen to the contractor's ideas on making it easier to build and think about how you can make their ideas work, instead of focusing on making them follow your design to the T.
3. Tell the contractor what you're looking at and why. Ask if everything is ready to be inspected and if there's anything, in particular, they would like you to see.
4. The contractor may be incorrect when they tell you something, possibly because the design is not clear, in which case you must be able to explain it. Don't use maths to do so. Visualise how the system is working and the components you're talking about, then give either a practical demonstration or draw out the problem and solution. If you can't do that, you don't understand the design, or the situation, well enough. Tell the contractor you'll come back to them, then return to the office and ask questions until you understand it.

Your inspection

1. Tell the contractor what you're looking at and why. Ask if everything is ready to be inspected and if there's anything, in particular, they would like you to see. Ask the contractor if there are any problems they can see coming up. A good contractor is an excellent ally to getting a job done right.
2. Make sure that you go around the job methodically, marking off what you're inspecting on your plans. If the contractor tries to rush you, or access to a certain area is restricted in some way, there's a good chance they're trying to hide something. Do not sign it off!
3. Take meaningful photos. For example, if you are inspecting a RibRaft slab, get a can of dazzle and write a number next to the items that need fixing. Relate that back to your construction monitoring report when asking for photos. That way, you can see that the contractor has done the work, and it's easy to check off.
4. When inspecting items, take a pencil and dazzle can, write a reference number on the element, and take a photo. That way, you can easily reference it in your report along with the photo.
5. Make sure you file your photos in the correct folder. Having your photographs named with the reverse data at the start is a good tool for more accessible filing later, e.g. 2016-05-26 George 45 footings.jpg
6. Always write up your construction monitoring reports as soon as possible. Ideally on-site.

GEOTECHNICAL

Excavation, clearing and demolition

1. Document the condition of all items to be salvaged, replaced, or relocated.
2. Ensure you observe the requirements indicating method or means of excavation and compaction etc. (if specified) are being followed by the contractor.
3. Notify the contractor and project manager if rock excavation or other materials not anticipated on the plans or in the quantity take-off are discovered during the work.
4. Notify the contractor and project manager immediately if any abandoned utilities, artefacts or objects of otherwise historical significance are uncovered during excavation.
5. When the contractor is stockpiling materials, check the location is suitable (i.e. not on or adjacent to steep slopes, streams, or compressible soils). Ensure the contractor does not exceed the maximum height and note that the side slopes and perimeters are protected as specified in the consented documents.
6. Check the separation and cover is as needed for stockpiled materials, including topsoil.
7. After demolition, observe the waste materials that the contractor removes are properly transported and disposed of off-site.

Placement/backfill

1. If the contractor uses on-site soils for placement/backfill, check they are free of debris or organic content such as weeds, grass.
2. Check the type and grade of materials for placement/backfill to verify the content and gradation is as specified in the consented documents.
3. Check all material certificates provided by the contractor to verify they are according to the specifications and/or submittals. Provide the originals to the project manager and file copies for your records.
4. Spot check the depth of the lifts during placement/backfill of materials.

Compaction tests (refer NZS 4431 for details)

1. Compaction tests for soils are usually specified as a percentage of the maximum density as determined by, or in accordance with, a standard ASTM proctor test (sometimes referred to as a moisture-density test).
2. Indicate the location of the test sample on the site plan if you require more than one sample on the project.
3. The test results should indicate the soils plastic and liquid limit and the related plasticity index.
4. Only qualified professionals (independent laboratory) should complete field compaction tests using a calibrated nuclear test gauge and other equipment as set out in the Fill Specification.
5. Document field test results and track the date, location and depth of all tests completed.
6. Notify the contractor and project manager of any failed compaction tests and observe the retesting of any failed work.

Soil moisture content

1. The moisture content of the material in the field should be within a specified percentage of the optimum moisture content for compaction.
2. The contractor is responsible for directing the wetting or drying of the material to meet the specified range prior to compaction. Never direct the work of the contractor to meet the specification.
3. Notify the contractor and project manager if the moisture content is not within the optimum range.

Method and frequency of testing

1. The number of tests required at each location is usually specified. If not, notify the project manager.
2. Testing requirements for compaction may indicate the number of tests per square meter for each layer of material. Compaction testing once every 1,000m3 for each lift of material placed is typically acceptable if the contract documents do not state this. If in doubt, check with a senior engineer.
3. Proctor tests (compaction curve) should be prepared for each type and grade of material proposed for the project (including hardfill).

Sub-grade works

1. Carefully read the geotechnical and lab reports before works begins and note the location of bores, type of soils and recommendations for compaction.
2. Watch for any changes or discrepancies in the soils (color, texture to feel, etc.) placed and notify the contractor and project manager if you spot any.
3. Verify the material is spread uniformly in successive layers and, when compacted, meets the specified depth. Check that each lift does not exceed the specified depth.
4. Watch the wetting of the material surface before it's compacted and note the moisture content of the soil during field density tests. Be aware of the sensitivity of the optimum moisture content and meeting compaction requirements.
5. Observe the sub-grade while it's undergoing compaction by heavy equipment, note any movement (pumping or rolling) or deflection of the soil, and notify the contractor and project manager.
6. Observe the placement and overlapping of geogrid or geofabric (if used) as specified in the consented documents.

Proof-roll testing

1. The contractor typically performs a roll test just before the approval of the sub-grade. The test consists of driving a fully loaded dual axle truck within each traffic lane and observing any sub-grade rutting, pumping, or deformation.
2. While walking alongside the truck, observe any signs of deformation or rutting and notify the contractor and project manager.
3. Document any areas that fail the roll test. The contractor needs to rework and them and have them retested.

FIRE

The Society for Fire Protection Engineers has produced construction monitoring guidelines that provide recommended service levels for projects. We recommend that you read the document and familiarise yourself with how it affects your job before going on-site.

1. Before attending the site, review the documentation on what system(s) you are observing for familiarity with the make and installation requirements. The New Zealand Building Code clearly states that the system shall comply with tested standards.
2. The usual issues arise when inspecting passive fire protection systems because of limited consenting details. The Fire Engineers scope should be clear from the outset as site instructions need to come from the appropriate source.
3. Ensure you have had health and safety training and remember roof space areas may be considered confined spaces, so caution is advised.

Passive Fire Protection Systems

Construction monitoring of passive fire protection consists of reviewing architectural features, including fire/smoke walls, floors and connection details, and services penetrating these elements. General parameters for review of these systems are noted below and consider material typologies.:

1. Concrete walls and floors
2. Lightweight timber-framed plasterboard systems:
   a. The screw types used are as per manufacturer's requirements.
   b. Check the screw spacing follows the manufacturer's specifications.
   c. Check screws have not cut into the plasterboard.
   d. Check the joint gaps between sheets are no greater than 5 mm.
   e. Ensure no screws are located in the top track on any deflection head walls.
3. Service penetrations:
   a. Check the passive fire systems are fit for purpose and the contractor has installed them as per the manufacturer's specifications.
   b. Check fire separation construction – any defects?
   c. Check the fixing details and joinery between the elements matches those on drawings
   d. Check the tolerances in the design match those on-site.
4. Fire/smoke doors: Check to ensure doors close and latch shut in case of a fire door.

Active systems

1. Check the contractor has installed the fire alarm systems as needed throughout the building. Close to completion, participate in fire alarm witnessing tests to ensure the system operates as intended.
2. Check fire doors are in the correct places and check that they close and latch shut. You should only undertake this check once the contractor has installed all floor linings to ensure the carpet does not prevent the door from closing.
3. Check the smoke doors are at least 43 mm thick solid core doors, and labels have been provided.
4. Check that any hold-open devices allow the door to close and shut when disconnected from the power supply.
5. Check automatic doors continue to work when disconnected from the power supply. This check can be as easy as turning off the switch located at the top of the door.

STRUCTURAL

Foundations/masonry walls

1. Always check the cut height of a bank. You can use the level/clinometer on your mobile phone to measure the slope – just sight along the top of your phone.
2. Never believe that:
    a. the hole is deep enough without checking it yourself
    b. the contractor has gone into rock unless you can see the rock and you can see the rock in the spoilings.
3. When inspecting concrete foundations and footings, ensure the contractor has installed chairs to support the mesh and rebar. The contractor should have cleaned out the site and squared off the trench edges. Having rubbish or loose pieces of polystyrene in the foundations is unacceptable.
4. Ideally, the contractor will have lined the foundation with DPM (Damp Proof Membrane) or site concrete.
5. An easy way to establish side clearance is to have the contractor install chairs against the side walls.
6. Ensure the slab is a suitable thickness if a specific system is installed within it, e.g. 120mm thick if there is hydronic heating within the slab.
7. The setback of the steel is critical when building retaining walls. The steel should be tied back to a solid support so it cannot move during the pour. Tell the contractor it's good practice to do so if it's not tied back. Mention it in your site report and take a photo! Doing so can save you if the steel moves during a pour and the contractor hasn't tied it securely.
8. Ensure all control joints are as per the approved plans. If there is a reason for the change, all parties involved in the project need to be informed.

Beams, columns, portal frames

1. When checking steel beams, measure them. Steel yards can deliver the wrong sized beams, and it can be difficult to see they are the wrong size without a tape measure. If you're checking a UB or UC, measure it and check the measurements against the specified beam.
2. When inspecting connections, take a pencil, write the beam number on the connection, and take a photo. That way, you can easily reference it in your report along with the photo.
3. Check the washers. Washers on timber are always square. Washers on steel are always round. These must be correct for the connections to work as intended.
4. Check the contractor has appropriately tightened the nuts. As a basic test, try them by hand. Make sure they aren't tight enough to crush the timber.
5. Check that the contractor has correctly installed portal frames connections. It is common for the contractor to cast bolts in the wrong position. They frequently try to fix that by bending them into place. That is unacceptable. Sometimes there will be cut slots in the baseplate for the same reason, and you may need to redesign the connections at that point.
6. Some contractors forget to tighten the nuts, and you can pull bolts out by hand. If that occurs, demand a reinspection.

Earthworks

1. Check to see that no shortcuts have been taken, e.g. an existing fence retained to save cost, resulting in a new location of retaining walls.
2. Check cuts and fills are at the required level as stated on the plans. You can check heights from the datum shown on the approved plans. Sometimes contractors assume the height is correct when using a more convenient datum point, resulting in inaccuracies and potential district plan breaches.
3. Check that trenches over 1.5m deep have been shored or benched.
4. Check that service trenches are in the location as shown on the plans. All services must have a minimum separation if installed in the same trench.
5. Check sediment and erosion controls as per the erosion sediment control plan (ESCP)

Timber structures

1. Plumbers and electricians often cut big holes into studs and beams to run cables and pipes. Keep an eye out for them. If they are on-site, ask them if they will have to drill through studs or beams. If done incorrectly, the contractor may be required to undertake on-site strengthening, and in some cases, amendments to the bracing schedule may be necessary.
2. Ensure all timber is of the correct treatment and stress grade as stated in the approved plans.
3. Ensure timber has not been exposed to the weather for more than six weeks as treatment and integrity of the timber may be affected.
4. Ensure the contractor has installed tie-down connections correctly. These frequently include corners or wall ends, at the base of lintels, beams and bracing systems. In fire-rated systems, it may be necessary to have a connection on each side of every stud in the fire-wall.
5. Check the increased stud sizes for higher walls are installed correctly per the approved plans.
6. If the design requires a wind beam, ensure the contractor installed it per approved plans.
7. Check beam sizes and timber types. In some situations, a contractor may install a different kind of engineered timber that may not meet the requirements of the approved design.
8. Check steel connections are suitable for the corrosion zone and height to the ground. Type 314 Stainless is required for connections in Corrosion Zone D, if within 600mm of the ground and in timber with copper-based treatments.

Concrete structures

1. Check the bars are the correct size and grade—find out how to find the difference between HD500 and HD300 grade reinforcing.
2. For precast units, check all connections and starter bars are consistent. You don’t want to crane in the element only to find an issue.
3. Ensure the contractor has installed all steel reinforcing for in-situ concrete as per the approved documentation.
4. Ensure control joints are at required locations – typically 6m maximum spacing. Check that the connectors through the joints are de-bonded round bars. Contractors will frequently try to use standard deformed reinforcing.

Steel structures

1. Ensure all steel is fabricated as per the approved documentation, including all connections and service holes.
2. Visually check exposed steel is primed and coated as per the approved documentation. Often a supplier will have provided a PS3 for the coating, and you should retain a copy of that document.
3. Ensure timber packing is separated from the steel with DPC or an alternative thermal break
4. If within an external wall of a roof structure, ensure that thermal bridging is accounted for to prevent condensation within the structure.
5. Confirm the contractor has installed end caps on the upright rebar.

Timber pole retaining walls

1. Ensure holes are drilled to the specified depth of approved plans before pouring concrete
2. Ensure all timber elements are of the correct treatment, stress grade and size of the approved plans.
3. Ensure that drainage and drainage metal is installed behind the wall. Check the drain has been wrapped in filter fabric and drains towards the sump.
4. Galvanised steel in contact with treated timber (for example, an anchor passing through the wall) should be wrapped in tape and greased to avoid electrolysis where it may come into contact with the timber.

CIVIL / EARTHWORKS

1. Check sediment and erosion controls are installed as per the erosion sediment control plan (ESCP).
2. Check silt fences are toed in, and there are safety caps on posts.
3. The contractor should replace sediment controls at the end of day. Check they look as if that has happened.
4. Check a vehicle wash is in place and dirt isn't being tracked on the roads.
5. Check the vehicle access point is stabilised and clean.
6. Check safety fencing and site sign in control, diversion bunds in place
7. Check that QA documentation is progressively completed for earthworks and services trenching.

STORMWATER / WASTEWATER

- Check QA documentation of trenching bedding and backfill material.
- Progressively confirm trench and backfill is as per design drawings.
- Check drains are sighted and laid at the correct gradient
- Check benching of completed manholes is smooth, to the specified finish.
- Pipe penetrations are smooth to the specified finish
- Check manhole lids are secured and level, check inside for spacers and smooth grout finish

If you have additional advice for inclusion with future iterations, please email it to: **hello@engineeringnz.org** Attn: Engineering Practice