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Issue 013, July 2011

From the Chair...

Update from the Chair – 24/06/11

Here we are halfway through the year already. The shorter days and recurrent wet weather will see most of us running for calibrations, management reviews and internal audits. Time to clean house and prepare for the next season, IANZ audit and, if you're lucky, securing those World Cup tickets for the end of winter.

Those on the committee that I have spoken to, tell me that work is steady and many have forward workload to plan for. This is perhaps a sign that our industry is making its way towards recovery. Some, like me, that have recently lost staff or down sized, are thinking about recruiting new people. This means an increased level of in-house and external training.

Good timing if you ask meYes they are here! The new National Certificates in Infrastructure Civil Engineering: Level 4 - (Laboratory Technician) and Level 5 – (Senior Laboratory Technician). This issue of CETANewZ will focus on the launch of the new qualification; its structure, content and benefits.

Most of you that were present at our first conference will remember that a "Specific Civil Laboratory Qualification" was one of the cornerstone issues that led to the formation of CETANZ. It has become one of the main drivers of the CETANZ organization and an area that receives a significant amount of resourcing, most of which is volunteered by our CETANZ members. I would like to thank all those people and their parent companies for donating their time and energy to this project. We couldn't have done it without you:

Graeme Duske – Coffey Information
Paul Burton – Geotechnics
Murray Cleveland – Testlab Wanganui
Toni O'Regan – City Care
John Evans - OPUS
Steven Anderson - Geotechnics
Eric Patton – Fulton Hogan
Stuart Moulding – Civil Train
Howard Jeffrey-Wright - Downers
Kevin St John - Retired
Grant Bosma – Fulton Hogan
Sean Beardsley - Higgins

And finally a special thanks to the team at InfraTrain for your input, guidance and patience.

As this newsletter goes to press I imagine that many of you would have by now been contacted by an InfraTrain representative who will be wanting to visit and talk to you and your staff about the new qualifications. We here at Stevenson have just had the pleasure of meeting Jim Kelly (InfraTrain Regional Manager). Jim met with all six of my technicians and explained how the qualification worked. I anticipate that several of my staff will enroll in the next week or two.

I see this as a major turning point in our industry and am intent on fully supporting it where I can. My own lab has already committed to setting aside time for assessments and evidence gathering for any of the technicians that decide to register. When it comes to recruiting and reviews, preference will be given to those that hold this qualification. New recruits will also be encouraged to sign up.



From the Chair Continued...

In the background as I have prepared for this launch, I have undergone the two day assessor training with InfraTrain. I'm proud to say that my certificate and stamp arrived yesterday. Murray Cleveland, Rhys Jones, Toni O'Regan and I attended the initial training session in Nelson back in June. At the training we talked a lot about the process of assessment and moderation of assessors, carried out several practice assessments on each other and learnt about unit standards, InfraTrain and the NZQA.

For those managers or senior people that intend on encouraging their staff to enroll, I would suggest you consider becoming an assessor as well. In the long run it will save your organization money. Please contact me to go over the criteria if you're interested in pursuing this opportunity.

Before I leave you to get up to speed on the qualifications talked about in this newsletter, I would like to mention that work also continues on other many other CETANZ initiatives. Proficiency samples have been delivered, the review of NZS 4407 test standards is making good progress and we have started to hold regional social events. The 2012 conference planning is underway and the winner of the travel grant has been announced. I look forward to full reports from the working groups in the next newsletter.

Jayden Ellis
CETANZ Chairman

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From the Editor...

Last week I was in Rotorua for the IOQ Quarry NZ conference and as part of the Geotechnics exhibition, I had some CETANZ promotional and advertising material to try and increase our exposure outside of our immediate industry. Quarry managers and engineers alike are generally interested in what we are striving to achieve as testing of their aggregate for their QA and QC is a very important piece in the bigger picture.

I believe it's important that we increase our membership throughout the wider engineering industry so I urge our members to promote CETANZ through word of mouth when speaking to various parties in your every day work.

I'm very impressed with where CETANZ has come from since the very first meeting we held in a tiny Auckland meeting room in early 2007 and in this issue we are paying special attention to the launch of the qualification which is a tribute to not only CETANZ but also our friends at InfraTrain.

I must say in my dealings with Andrew Taylor and Abigail Kibble from InfraTrain on the marketing and promotion side of things, they have been very professional and have had our best interests at heart throughout the whole process.

While several senior managers have completed the assessor training and there are an increasing number of enrolments in the qualification, we haven't been resting on what we have achieved so far. A subcommittee for the 2012 Conference has been formed and we are busy booking venues and organising the event for what promises to be an even better conference than before. It's only our 3rd biennial conference and to think that the IOQ Quarry Conference is in its 43rd year, we are an extremely young society with plenty of potential.

We had investigated members feedback, as to holding the 2012 conference outside of Auckland however, due to the difficulty of getting papers and the amount of time needed to put such an event together the committee has decided to hold the next even in Auckland.

I am proud to be convening this event again in 2012 and the subcommittee have recently met to get planning for the event underway. We will shortly be announcing the date and venue and producing the conference prospectus. We have once again hired the services of John Walker to organise our conference and for the second time, MC Bruce Hopkins will direct proceedings. This is a combination we wanted to keep and I hope it continues for many conferences to come.

That's about all from me – I hope you enjoy the 13th edition of your newsletter.
Wishing you all a safe and busy winter.

Michael McGlynn



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New InfraTrain Qualifications For Civil Engineering Laboratory Technicians

InfraTrain New Zealand is now taking the first enrolments for its new qualifications for civil engineering laboratory Technicians.

These qualifications have been developed with CETANZ (the Civil Engineering Testing Association of New Zealand), which identified a need for a structured career pathway, based on qualifications, for civil engineering laboratory technicians.

CETANZ Chair Jayden Ellis explains, "It has always been difficult to provide a laboratory based career pathway. Now, with the new qualifications for civil engineering laboratory technicians, we can attract a whole new range of people looking to train for a vocation, and we can upskill those technicians we already have who can't commit to classroom studies."

The qualifications have been specifically designed to recognise the skills and knowledge required for civil laboratory testing. They are available at two different levels, making them suitable for people who are new to the industry, as well as experienced technicians.

National Certificate in Infrastructure Civil Engineering (Laboratory Technician) - Level 4

This qualification is recommended for people entering the civil engineering testing industry, or in roles such as technical assistants, technicians, instrument operators or similar.

It recognises the skills and knowledge required to undertake sampling and testing, including a broad range of technical skills and some scientific knowledge. The qualification is made up of core compulsory and elective units. The units cover the core skills and knowledge needed to work at any level in a laboratory.

The qualification is completed with one of the following elective strands:



Aggregate	Soil	Concrete
Bitumen	Asphalt	Field Testing

National Certificate in Infrastructure Civil Engineering (Senior Laboratory Technician) - Level 5



This qualification is designed for people in roles such as technical officers, senior laboratory technicians, analysts or similar.

It is aimed at those who already have the skills and knowledge to carry out sampling and, and recognises the advanced skills and knowledge to explain, evaluate and troubleshoot tests.

The qualification is made up of core compulsory and elective units which cover skills including job safety analysis, giving oral instructions, leading a group or team, and auditing quality management systems. As with the Level 4 qualification, it is completed with one of six elective strands.

The two qualifications are designed to be stand-alone, and there are no prerequisites for entry. However, they are structured to provide a career pathway for civil engineering laboratory technicians who want to progress to a senior role. They can also be complemented by other InfraTrain qualifications, such as the *National Certificate in Business (First Line Management)* or *National Diploma in Civil Engineering (Applied)*.

InfraTrain has worked closely with CETANZ to ensure that both qualifications reflect industry best practice. Former CETANZ Chair Paul Burton says, "The integration of industry experts from CETANZ into the development process has ensured the qualifications will be up to date and relevant. These National Certificates will provide all students with an excellent overview of the industry at beginner and senior levels."

The cost of the qualifications is subsidised by InfraTrain, making them very affordable.

Modern Apprenticeship programme

Young people can train for a career as a civil engineering laboratory technician with an InfraTrain Modern Apprenticeship programme.

The Modern Apprenticeship programme is open to 16 to 21 year olds, and follows a structured training plan, with a focus on goal-setting and achievement. The programme is based on the *National Certificate in Infrastructure Civil Engineering (Laboratory Technician)* – Level 4, and will last from 11 to 15 months, depending on the strand selected.

Generous subsidies are available for Modern Apprenticeships. InfraTrain provides a subsidy of \$1,000 when the Apprentice completes the National Certificate, and further subsidies are available to support approved off-job training that will enhance the Apprentice's career.

The programme is ideal for young people who have shown initiative and an aptitude for the industry, and who are keen to progress in their careers.

Direct link to Modern Apprenticeships brochure on InfraTrain website:

<http://www.infratrains.co.nz/Resources/Modern%20Apprenticeships%20brochure.pdf>

Link to Modern Apprenticeship page on InfraTrain website:

http://www.infratrains.co.nz/Modern_apprenticeships.htm

How are the qualifications achieved?

Both qualifications will be achieved using a proven model of industry training with no classrooms or exams. Trainees will gain recognition of real skills and knowledge while working in a civil engineering laboratory.

Trainees will be provided with a workbook which will explain what needs to be done in order to achieve the qualification. The trainee will collect evidence of their skills and knowledge in the workbook, for verification and assessment against unit standards which make up the qualification.

Because they are completed on-job, InfraTrain's qualifications for civil engineering laboratory technicians can be started at any time of the year. They offer flexibility for the employer and trainee, and learning can be mapped out to meet company and individual requirements. In addition, the elective strand gives the trainee the opportunity to gain skills in specialist areas relevant to their work.

Key people

A number of people provide support to the trainee during the on-job training process.

Employer

The employer has overall responsibility for the trainee's training. It is their job to ensure that the trainee has the opportunity to gain all of the skills they need to achieve the National Certificate, for example through rotation in different jobs.

They are also responsible for arranging for technical experts to act as a mentor and verifier(s) for the trainee.

The employer will be required to regularly review the trainee's progress to ensure that there are no barriers to them completing the National Certificate. They have a critical role in providing encouragement, support and incentives for the trainee to maintain motivation and complete the qualification within the required duration.

**Mentor**

A mentor is appointed by the employer and can be a colleague, advisor or manager of the trainee. A good mentor will have extensive industry experience, be committed to training, and have a sound understanding of the qualification process. They will also take a hands-on approach, and be actively involved in the trainee's development. One of the mentor's key responsibilities is to ensure a structured approach to work and training, so that the trainee gains all of the skills and knowledge they need to complete the tasks in the workbook.

The mentor also ascertains when the trainee is ready for assessment, for example by ensuring they have collected enough evidence in their workbook to meet the requirements of each unit standard.

Verifier

A trainee will need one or more workplace verifiers. The main responsibility of the verifier is to observe and confirm the work in the workbook is the trainee's own, and that it has been completed to an acceptable industry standard.

The verifier may or may not be the same person as the mentor. They are appointed by the employer, and must have extensive experience in the area which they are verifying.

The verifier must be accepted by the assessor before the verification takes place.

Assessor

All trainees will have an InfraTrain registered assessor available to them upon enrolment. All assessors are approved by CETANZ and have extensive industry experience.

The assessor's role is to assess the evidence in the trainee's workbook against the unit standards which make up the qualification.

InfraTrain Regional Advisor

An InfraTrain Regional Advisor will be available to provide support to the trainee and their employer for the duration of the National Certificate.

The main responsibility of the InfraTrain Regional Advisor is to work with the employer and trainee to ensure that the trainee is making good progress. This is usually achieved through regular workplace visits and phone calls to review the trainee's work and identify any issues.



For further information visit the InfraTrain website: www.infratrains.co.nz

Alternatively, call InfraTrain on 0800 486 626, email: askus@infratrains.co.nz to find out more.

InfraTrain Assessor Training Courses

After participating in the May course held in Nelson, it was thought a few comments on the course could be worthwhile & of interest to members considering the course.

Despite the unfortunate short notice for the course, 4 CETANZ members joined 5 other candidates from the Civil Infrastructure sector for the 2 day course. Those of us from Civil Labs represented a variety of backgrounds/experience in assessing & some held assessing qualifications from other providers also.

The 1st day seemed a little dry as we necessarily learnt about the NZQA system, the legalities of the assessor system, methods of moderation, support available from InfraTrain etc. but in fact, as the various subjects were covered, a number of questions arose from around the room as people digested the information in the context of their own work/training environment which led to some excellent discussion & clarification. Like most courses of this duration, the 2nd day was centred around some practical assessing processes & systems which brought the learning from day 1 into focus.

On completion, the Lab staff involved all agreed that the course had been worthwhile & had certainly allayed a number of pre-course concerns. From my own point of view, the learning of the previously held assessment units had not been wasted, but in fact was reinforced during the course as we gained the InfraTrain culture/approach to assessing our qualification.

It is important for a number of members to qualify as assessors in order to cover the needs of our industry training in a variety of locations, however that does not mean that we must have an assessor in every workplace, as there is no need for the assessor to be directly involved with the training. Overall, our primary focus as an industry should remain the continued up-skilling of all our workforce while maintaining quality & transparency of our systems. "Go for it"

Any further enquiries can be directed to:

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TestLab Wanganui.

0274 481 758

murray@testlab.co.nz

Particle Shape Testing of Coarse Aggregates

- David Morgan, Winstone Aggregates, Hunua, New Zealand

Recently KiwiRail has been reviewing its specification for the supply of Railway ballast. While this is normally more an issue for aggregate suppliers, the changes this time have also involved the specifying of higher test frequency and a subtle shift in test methods which will be of some interest to aggregate testing labs. In this article we will take a brief look at changes to the specified particle shape test methods and implications for lab testing.

Previously KiwiRail have written a spec that was rather broad. When assessing aggregate properties the spec allowed for a couple of different methods for similar tests. A good example is the Particle Shape, where labs could test using either ASTM D4791 or AS1141.14.

The test methods are very similar (identical in principle) but there are minor technical differences between the two which have the potential to give some issues for test labs.

For those unfamiliar with the method the Particle shape test (also known as the Proportional Caliper) involves classifying representative size fractions of an aggregate sample into flat particles, elongated particles, both flat and elongated particles and normal (cubical) particles. The particles are classified using a proportional caliper at a specified ratio (usually 2:1). From a technicians perspective this is a test to avoid as it involves checking over 100 stones from each size fraction of sample that contains more than 10% of the sample (experience shows this to normally mean testing 200-400 stones for a typical ballast sample).

During the recent KiwiRail Ballast Review the option to test to either ASTM D4791 or AS1141.14 was removed and replaced solely with testing to AS1141.14.

For a lab that is changing to the Australian method it's recommended that the standard is read carefully and equipment and worksheets are checked for compliance thoroughly.

For example, something to look out for: The ASTM method gives an example of a suitable caliper which can be checked for compliance with the use of a micrometer or a gauge block (Figure 2). The Australian method calls for a caliper with toleranced dimensions on swing arms etc.(Figure 1). Checking the caliper at the Winstone Aggregates lab showed that although the caliper was fit for purpose (as far as the ASTM method was concerned) it simply would not comply with the Australian method resulting in the need to purchase a complying item.

This difference, along with other small differences, underline why it's useful to use a single standard method. It means customers can compare apples with apples as everyone is assessed the same. It also reinforces the importance of considering new methods carefully at a lab level before beginning test to ensure details aren't missed.

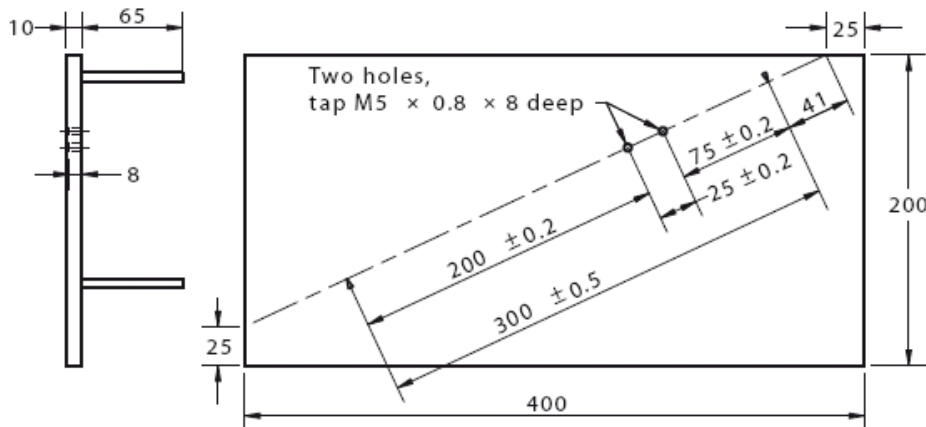


Figure 1 - AS1141.14-2007 Caliper requirements

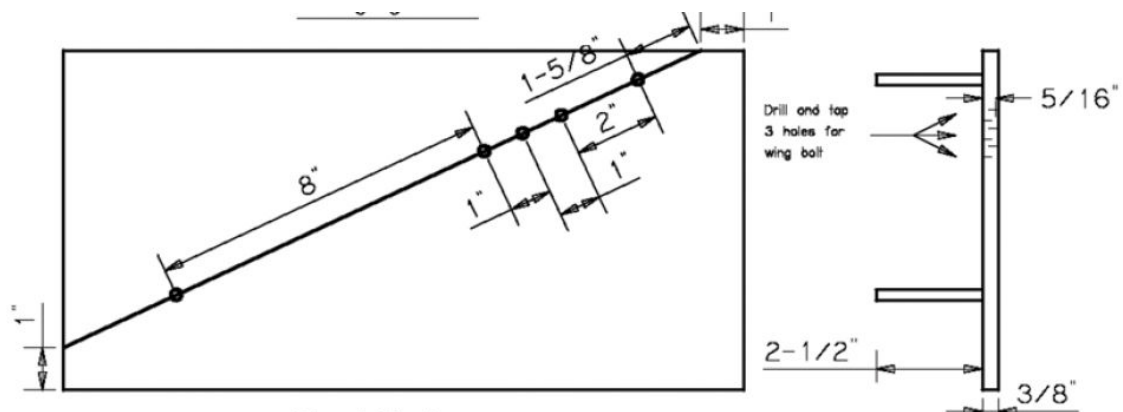


Figure 2 - ASTM D4791-10 showing useful dimensions for a calliper



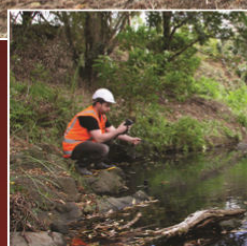
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InfraTrain Media Release

05 April 2011

InfraTrain scholarships create opportunities for budding engineers

Seven Māori working in the civil engineering sector are a step closer to achieving their career goals, after they each received a \$10,000 National Diploma Scholarship.

The Scholarships were awarded by the Industry Training Organisation, InfraTrain New Zealand, as part of its *Te Poutama Kaiahumahi* programme. The programme is run in partnership with Te Puni Kōkiri, and aims to strengthen the skills and qualifications of Māori working in the civil infrastructure industry through a range of initiatives, including Scholarships towards industry Diplomas.

The Scholarship winners are employed by contracting companies, consultants and infrastructure operators from around New Zealand. Under the Scholarship they will study for a *National Diploma in Civil Engineering (Applied)*. An eighth Scholarship was awarded to a survey cadet from Hamilton, who will work towards a *National Diploma in Surveying*.

InfraTrain has awarded a total of eighteen National Diploma Scholarships since it started working with Te Puni Kōkiri at the end of 2008. The latest winners were presented with their Scholarships by the Minister of Māori Affairs, Hon Dr Pita Sharples, in Auckland on 25 March.

Speaking at the presentation, Dr Sharples said, "It really is wonderful to be back again to present further Scholarships and recognise the ongoing success of *Te Poutama Kaiahumahi*. The winners represent the aspirations we want to stimulate within the wider Māori workforce. That is; of a skilled, talented and highly qualified workforce realising its potential."

Dr Sharples continued, "What is great about the *Te Poutama Kaiahumahi* programme is that the benefits flow two ways. On one hand, Māori staff improve their skills and gain qualifications which improves their job and promotion prospects. On the other hand, employers will gain higher productivity and efficiencies."

InfraTrain Chief Executive Philip Aldridge said, "InfraTrain congratulates all of the Scholarship winners. The applications were of an extremely high standard, and we were impressed by their motivation and commitment to their careers. We expect great things from them in the future!"

Philip added, "Skilled, qualified civil engineering technicians in great demand, and there are tremendous career opportunities available. We are confident that the Scholarships will enable the winners to participate fully in these opportunities, and to be extremely successful in their chosen fields."

GROUP PHOTO CAPTION:

InfraTrain National Diploma Scholarship winners (from left to right):

Shannan Baker (Ngā Puhi, Ngāti Kahungunu, Ngāti Porou), MWH New Zealand Ltd, Invercargill

Elijah Graham (Ngāti Kauwhata, Ruakawa), Graham Contractors Ltd, Hamilton

Matthew Joli (Ngāi Tahu), Worthington Contracting Ltd, Rangiora

Manga Nathan-Patuawa (Te Roroa, Ngāti Whātua), Transfield Services (NZ) Ltd, Whangarei

Garreth Oien (Ngāti Kahu, Patukoraha), Transfield Services (NZ) Ltd, Kaitiaki

Brian Ponton (Tuhoe, Ngāti Whare), Downer NZ, Tauranga

John Te Iringa (Te Rarawa, Atihaunui a Paparangi, Maniapoto), KiwiRail, Whangarei



InfraTrain Media Release Continued

NOTES:

Te Poutama Kaiahumahi (Stairway to industry achievement)

InfraTrain's *Te Poutama Kaiahumahi* programme is run in partnership with Te Puni Kōkiri. It aims to strengthen the skills and qualifications of Māori in the civil infrastructure industries, so they can participate fully in the career opportunities available.

The *Te Poutama Kaiahumahi* programme facilitates training by:

- Supporting new Māori trainees in the industry to gain industry skills and qualifications.
- Supporting Māori who presently work in the industry to gain higher level qualifications.
- Encouraging young Māori to enter the industry through the Gateway programme.
- Supporting community initiatives with industry skills and training.
- Offering Scholarships toward an Industry Diploma.

For more information contact:

Abi Kibble, Communications Advisor, InfraTrain New Zealand
Telephone: 04 494 2333, mobile: 021 859 260, email: abi@InfraTrain.co.nz
InfraTrain website: www.InfraTrain.co.nz

First enrolment – Senior Laboratory Technician

Clare Andrews of Opus Laboratory in Hamilton is the first person to enrol in the *National Certificate in Infrastructure Civil Engineering (Senior Laboratory Technician)* - Level 5.

Clare won the business card draw at the CETANZ Conference 2010, and received a complimentary enrolment into an InfraTrain civil laboratory qualification of her choice.

Congratulations Clare!



CETANZ TRAVEL GRANT WINNER!!

Congratulations to Stuart Moulding with his paper, 98% of What?

The paper which is currently being finalised was presented as part of the Road Engineering Association of Asia and Australasia (REAAA) 2010 road show and received very good feedback. The paper touches on the work that CETANZ has done around the controversial vibrating hammer test and extends a few steps further by looking in detail as to how these numbers are applied, and indeed verified in the field.

Stuart will travel to the AGTA conference in Brisbane on the 12th - 14th of October to present this paper.

Congratulations Stu!



TECHNICIAN / TRAINEE TECHNICIAN Aggregates, Concrete, Masonry & Soils.

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We are seeking applicants interested in entering this industry as a trainee technician (no experience necessary as training is provided) or those that have worked in a civil laboratory and would like to continue their career.

Ideally you will:

Have an interest in or knowledge of quarries, earthworks or cement products.

Have good mathematical oral and written communication skills.

Have achieved NCEA Level 2 or equivalent.

Have experience with computers, specifically with using Word and Excel.

Have the ability to work in a team, and on your own.

Be physically fit & mobile.

Enjoy the challenge of meeting deadlines even if it means working additional hours.

Be legally entitled to work in New Zealand.

Have a NZ Drivers Licence.

Candidates that have experience in a civil engineering laboratory or a qualification such as a Diploma in Engineering or Science will be given preference.

We offer an interesting and varied work environment coupled with an attractive remuneration. If this sounds like you, then please forward your CV to the General Manager at the following address, quoting Job Ref LB002. Please note that a pre employment medical examination including a test for illegal drugs will be required.

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EXPLAINING LIQUEFACTION WITH CHRISTCHURCH IN OUR MINDS

- Wayne Campton, Babbage Consultants, Auckland, New Zealand

WHAT:

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction and related phenomena have been responsible for tremendous amounts of damage in historical earthquakes around the world.

EFFECTS:

The effects of liquefaction may include ground surface disruption such as surface cracking, dislocation, ground distortion, slumping and permanent deformations such as large settlements and lateral spreads. Sand boils including ejected water and fine-grained fractions of liquefied soils are also typical manifestations of liquefaction at the ground surface. Landslides are common where slopes are too steep to stand when liquefied, and lateral spreading occur where an unrestrained face allows liquefied soil to move sideways under earthquake stress.

Liquefied soil also exerts higher pressure on retaining walls, which can cause them to tilt or slide. This movement can cause settlement of the retained soil and destruction of structures on the ground surface.

WHY:

A soil deposit consists of an assemblage of individual soil particles. Each particle is in contact with a number of neighbouring particles. The weight of the overlying soil particles produce contact forces between the particles - these forces hold individual particles in place and give the soil its strength.

Liquefaction occurs when the structure of a loose, saturated sand breaks down due to some rapidly applied loading. As the structure breaks down, the loosely-packed individual soil particles attempt to move into a denser configuration. For this densification to happen some of the water in the pores of the soil has to be squeezed out. In an earthquake, however, there is not enough time for this. Instead, the water is "trapped" and prevents the soil particles from moving closer together. This results in an increase in water pressure, which reduces the contact forces between the individual soil particles, thereby softening and weakening the soil deposit.



Earthquake shaking often triggers this increase in water pressure, but construction related activities that rapidly load the soil such as blasting can also cause an increase in water pressure. When liquefaction occurs, the strength of the soil decreases, and the ability of a soil deposit to support foundations for buildings and bridges is reduced.

WHERE:

Because liquefaction only occurs in saturated soil, its effects are most commonly observed in low-lying areas near bodies of water such as rivers, lakes, bays, and oceans. Loose young Holocene sediments and man-made fills in particular are susceptible to liquefaction because they can densify under shaking.

Port and wharf facilities are often located in areas susceptible to liquefaction, and many have been damaged by liquefaction in past earthquakes. Most ports and wharves have major retaining structures, or quay walls, to allow large ships to moor adjacent to flat cargo handling areas. When the soil behind and/or beneath such a wall liquefies, the pressure it exerts on the wall can increase greatly - enough to cause the wall to slide and/or tilt toward the water.

Liquefaction also frequently causes damage to bridges that cross rivers and other bodies of water. Such damage can have drastic consequences, impeding emergency response and rescue operations in the short term and causing significant economic loss from business disruption in the longer term.

It is obvious from examination of the Christchurch region that areas bordering the Avon River have lateral spreading damage due to the soft unrestrained banks losing strength. A very large part of the eastern city has dune sands and Holocene Alluvium which is prone to liquefaction overlying the bedrock. Amplification effects are pronounced in the areas to the north of the central city and in scattered south-western areas. These areas have a saturated, sand and silt rich sub-strata with a prograding coastline.



MITIGATION

Identification and mitigation of liquefaction hazards at a site firstly requires a thorough investigation of the site geomorphology. Assessment of the liquefaction hazard and its effects on structures involves several steps using firstly simplified then, if warranted more detailed analysis procedures.

A suitable investigation should include the following features:

- Continuous profile of subsoil to basement materials (usually by borehole and/or CPT)
 - Measurement of depth to water table
 - In-situ density testing of all susceptible strata (CPT or SPT)
 - Grading curves for susceptible soils
- Atterberg limit tests for all soils

Two approaches are generally used to mitigate liquefaction and its consequences:

- Soil improvement
- Structural modification

Soil improvement is commonly based on one or a combination of the following effects:

Densification to increase liquefaction resistance and reduce deformability of the soil (compaction, vibro-flotation, piles, preloading).

- Solidification through cementation of soils.
- Containment by reinforcement and soil mixing walls.

Drainage for increased permeability and faster dissipation of excess pore water pressures.

Structural modification can include:

- Piling through suspected materials
- Support floor slabs on piles or stiff raft

References:

New Zealand Geotechnical Society – Geotechnical Earthquake Engineering Practice, July 2010

<http://www.ce.washington.edu/~liquefaction>

Photos from Babbage Consultants Structural Division

