COGAN

COMPETENCY IN GEOTECHNICAL ANALYSIS

INDUSTRY NEEDS SURVEY REPORT

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EXECUTIVE SUMMARY

This report presents the results of a survey of users of geotechnical numerical analysis tools to determine their views on the application of such tools in industry, particularly related to competency and training. The results of this survey will be used to shape the development of the COGAN project deliverables so that they match the needs of industry as closely as possible. This work was carried out as part of the COGAN project (Competency in Geotechnical Analysis), funded under the European Commission's Leonardo da Vinci Programme.

A major goal of the COGAN project is to contribute to the competitiveness and quality of geotechnical engineering design in Europe through identifying the competences that users of geotechnical numerical analysis software must possess. A competency framework will be developed to include a comprehensive educational base, a web-based interface to look-up and record achievement of competences, with links to associated resource material that engineers can use to help gain competences. The project will also deliver two exemplar e-learning modules to cover key areas of the educational base.

The survey itself comprised an online questionnaire of 31 questions taking about 15 minutes to complete. It was completed by 619 respondents from 37 different countries / continents. A lot of invitations were sent out across a broad range of industry sectors in Europe and beyond, using the partners contact databases as well as local associations and companies. The high number of responses indicates that the subject is of high interest. All the metrics in terms of overall response rate, company size and seniority, set at the start of the survey were achieved. The margin of error for the survey results was estimated to be ±4.5%.

The majority of respondents were engineers/analysts and senior engineers, although project managers and directors were also well represented. The educational level of about half the respondents was to master's degree level, with about a third reaching doctorate level. Respondents were well distributed across all age groups and were generally well experienced in geotechnical numerical analysis.

Most responses were from design offices and consultancies, but contractors, universities and other research and development organisations were also well represented, as well as organisations of different sizes, over half of which were SMEs.

Responses to some of the questions confirmed that there exists a significant need in industry for the deliverables of the COGAN project. For instance, only 34% of respondents educated even to

doctorate level considered that their formal education related fully with their geotechnical numerical analysis activity.

Many organisations have low number of engineers engaged in geotechnical numerical analysis and many of these are part-time users of such tools. This suggests that many organisations have not accumulated a significant body of expertise in this field and with a lack of in-house expertise, many engineers will be in need of accessible, external training resources.

73% responded that there is no system to look-up and record achievement in competences in their organisations and a large majority (85%) thought such a system would be useful.

The four highest ranking issues concerning the application of numerical analysis in geotechnical engineering were “validation of analysis results”, “obtaining soil/rock parameters”, “lack of money/time for training” and “poor access to in-house experts or no mentoring system”, all of which can be addressed by the COGAN project deliverables.

The preferred media for a competency framework are a secure website and company intranet, while the preferred number of skill levels is 3.

Respondents also expressed their preferences for areas of geotechnical numerical analysis in most need of competency definition and to be covered by the COGAN e-learning modules. These results, together with the others, will be used to guide the development of the COGAN deliverables for the remainder of the project.

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1. INTRODUCTION

The purpose of this report is to present the results of a survey of the geotechnical engineering analysis and simulation industry to determine its views on the application of numerical analysis tools in industry, particularly related to competency and training. This work was carried out as part of the COGAN project (COmpetency in Geotechnical numerical ANalysis), funded under the European Commission's Leonardo da Vinci Programme.

1.1. COGAN project as a part of the Leonardo da Vinci programme

COGAN follows the general objectives of the Leonardo da Vinci programme and focuses in particular on two of its main general objectives, namely:

- to support geotechnical engineers in training and further training activities in the acquisition and the use of knowledge, skills and qualifications to facilitate personal development, employability and participation in the European labour market;
- to support improvements in quality and innovation in vocational education and training systems, institutions and practices.

Within the programme, under the lead of NAFEMS (UK) and the consortium partners Geofem (Cyprus), Terrasolum (Spain), Mott MacDonald (UK), TU Graz (Austria), Skanska (Sweden), EnginSoft (Italy) and WESI Geotecnica (Italy), the COGAN project has been undertaken with the goal to stimulate innovation and enhance the competitiveness of the European geotechnical engineering industry (through the development of skills in the workforce).

The main aim of this Leonardo da Vinci Transfer of Innovation project is to set out the knowledge and skills that a competent simulation engineer in geotechnical engineering should possess. The goal is to transfer, modify and extend the output from the EASIT^2 project (http://www.easit2.eu), which developed a competency framework and an educational database for generic engineering analysis and simulation to the specific field of geotechnical and geomechanical engineering.

There will be 3 main deliverables from the COGAN project:

- An "Educational Base". This is a set of detailed statements explaining what competences a good simulation engineer should have. This will be split down into about 15 modules, covering different areas of technology (e.g. fundamentals of finite element analysis, obtaining soil/rock parameters, constitutive models for geomaterials, etc). Links will be provided to appropriate books and training courses that will help individual self-learners to gain the appropriate competence and training providers to design focussed courses.
- A "Competency Framework". This will be a computerised system that will allow the skills that are developed by individuals to be tracked and logged. This can then be used by individuals to plan and monitor their career development as a geotechnical simulation engineer, or by companies to do the same for their staff and to keep a database of the combined simulation skills of their workforce.
- Two "Exemplar E-Learning Modules" for work-based learning, to achieve in depth the learning outcomes in two selected core competencies, and to promote the development of further modules by training providers.

1.2. Study of Industry Needs (WP1)

It is crucial that subsequent development of a geotechnical (non-product-specific) Educational Base, Competency Framework and the two E-Learning Modules, covering the education and competence of users of engineering analysis and simulation tools in the geotechnical industry, is informed by an accurate understanding of real industry needs. The aim of this initial work package was therefore to study the competency and training requirements across the geotechnical engineering industry. This in turn will directly influence the development of the Educational Base in WP2. The use of formal staff development structures was also examined, to ensure that the design of the COGAN Competency Framework in WP3 can provide input to such systems. Input was also sought on the development of the two E-Learning Modules in WP4, see Figure 1.

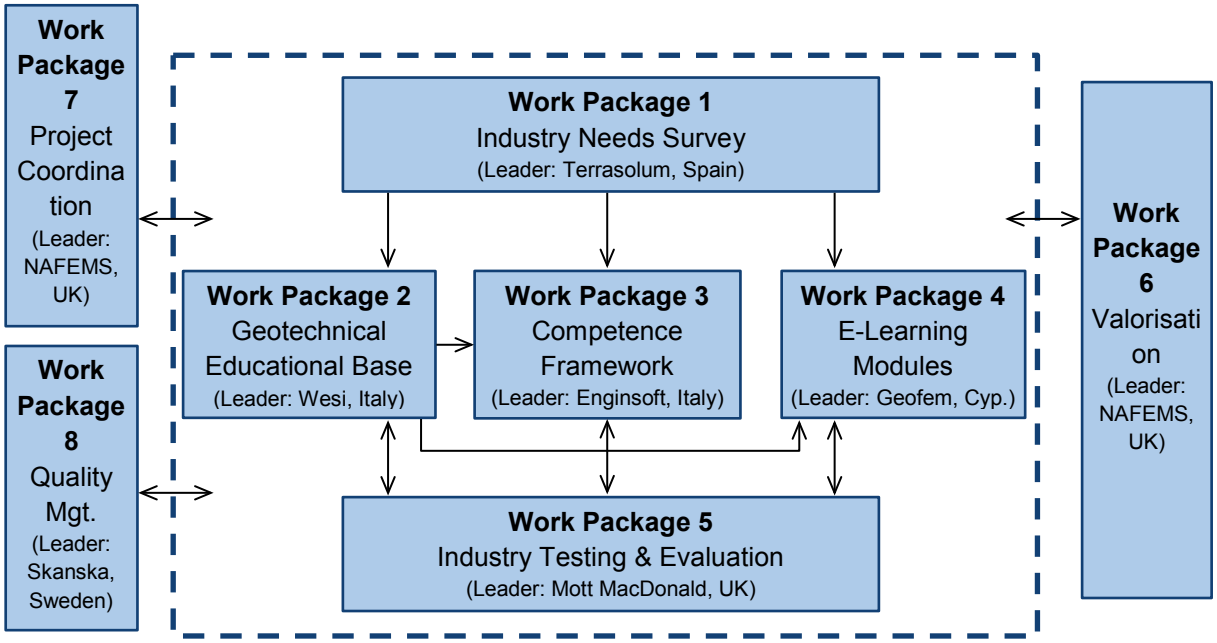

Figure 1 COGAN work package overview

2. THE SURVEY

2.1. The questionnaire

The questionnaire used in the survey comprised 31 questions divided into 5 sections in addition to a welcome page as well as a concluding page allowing respondents to add comments and to provide an email address on which to be contacted later in the project for evaluation of some of the project deliverables and to be kept informed about developments on the project. The sections were as follows:

2.2. Start

Introductory page

2.3. Your details

Respondents' location, age, position, education and experience are sought. The frequency of use of numerical modelling tools as well as the relation of the respondents academic education to current numerical analysis activity are also provided here.

2.4. Organisation details

Nature, sector and size of organisation, number of people using numerical tools in geotechnical analysis, issues concerning geotechnical analysis and simulation, different numerical methods used, fields where software is employed (soil or rock mechanics) and existence of competence management systems.

2.5. Existing system to record analyst skills at your organisation

Only if respondents indicated in the previous section that such a system existed at their organisation were they invited to complete this section by giving some details on the system's medium, number of skill levels and assessment method (as described in Figure 2). This was to ensure that the design of the COGAN Competency Framework can provide input to such systems.

2.6. Ideal system to define and record analyst competences

Preferred medium, skill levels, topics, focus areas and learning methods for inclusion in the Educational Base and Competency Framework.

2.7. Training needs

Respondents were asked their preferred learning methods and asked to select two topics for the E-Learning Modules of WP4.

2.8. Further comments

Respondents were invited to provide any additional comments and to declare whether they would be willing to evaluate some deliverables later in the project. On completing the questionnaire, respondents were thanked for their contribution to the COGAN Project.

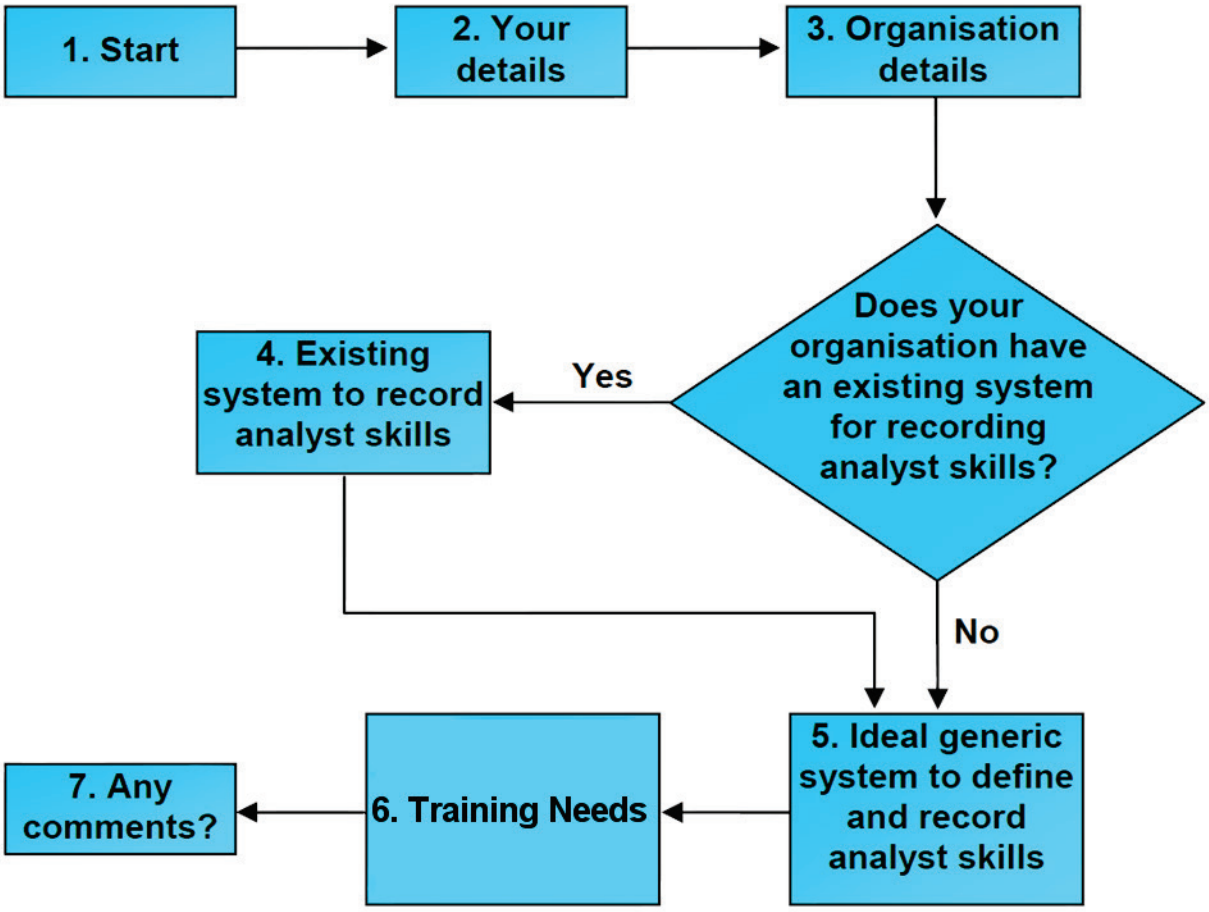

Figure 2 Questionnaire logic

The full set of questions is given in Appendix 1. The survey was conducted online using the website www.surveymonkey.com with which NAFEMS has conducted other successful surveys in the past. The website allows the straightforward setting up of surveys, data collection, data analysis and presentation as well as downloading of response data into spreadsheet programs for complete

freedom of data analysis and presentation. The use of a web-based questionnaire made it very accessible both to project partners and potential respondents. The starting page is shown in Figure 3.

Figure 3 Starting page of the survey

The survey was conducted only in English since this is one of the official European languages and is understood by many geotechnical engineers across Europe. It was agreed by all the project partners that this would not significantly deter respondents whose first language was not English and the significant cost of translating both the questionnaire and responses to and from multiple languages could not be justified. However, invitation emails to participate in the survey were translated into the national languages of the partners plus French and distributed in those countries. This was found to be very successful and there was no evidence in the response rates that engineers outside of the UK were discouraged from participating, indeed France, which is not represented on the project partnership, was one of the highest participating countries.

The questionnaire is based on the EASIT[2] questionnaire and was created by Terrasolum. The other project partners provided comments and suggestions during the drafting process.

2.9. Target group

A challenge was to reach a lot of geotechnical engineers at a European and international level, in particular through the national trade associations. These groups had to be contacted separately, using the project partners' contacts distributed across Europe. Furthermore, all partners were encouraged to disseminate the COGAN project and the survey in their country and beyond through national trade magazines, their contact networks, social media networks and membership of committees and societies. Invitation and reminder emails were sent out in English, German, French, Swedish and Italian to the corresponding countries with those national languages.

A valuable route to contact potential survey participants was also provided by software vendors who hold large databases of email addresses of geotechnical engineers for marketing purposes. While COGAN remains strictly software-neutral, five software vendors generously disseminated the COGAN survey through their email channels and this has been recognised on the COGAN website.

Links to the survey were also placed on the COGAN website and links to the COGAN website were placed on some project partner websites.

Due to this multi-channel dissemination process, it is impossible to know exactly how many engineers learned about the COGAN project and its survey, but it is estimated to be well in excess of 10,000 geotechnical engineers worldwide.

2.10. Anticipated impact

It is anticipated that the results of this survey will impact directly on the subsequent stages of the COGAN project, namely the development of the Educational Base, Competency Framework and the two E-Learning Modules. This survey will ensure the industry relevance of these project deliverables and help maximise industry take-up.

The survey has also raised awareness of the COGAN project in the geotechnical engineering analysis community, most particularly through the invitation emails which provided a brief explanation of the objectives of the project as well as a link to the project website.

2.11. Survey metrics

Prior to the survey going live, a number of challenging metrics were agreed between all the project partners by which to judge the success of the survey and to take corrective action if necessary. These are described below where it is shown that all the metrics were achieved successfully:

Metric 1. Achieve the number of respondents (**500**). Result: total number of respondents completing survey by 03/01/2014: **619**. **(✓)**

Metric 2. No more than **30%** of respondents from a single country, to ensure adequate cross-European coverage. Result: greatest participation from North America (**12.1%**), France (**11.6%**), Sweden (**10.8%**), Germany (**10.5%**) and Spain (**10.2%**). **(✓)**

Metric 3. At least **15%** of respondents to be at Project Manager or Director level. Result: 8% Project Manager, 9% Director, total **17%**. **(✓)**

Metric 4. At least **25%** of respondents to be from SMEs to ensure that they are adequately represented and that their training needs are identified. Result: respondents from SMEs **59%**. **(✓)**

2.12. Margin of error

A key question in surveys of this type is "are the respondents representative of their community?". The margin of error cannot be calculated for this survey from the laws of probability since the true population size (all geotechnical engineers worldwide) is unknown and because the sample was not randomly selected but rather was self-selecting since recipients of the invitation emails decided themselves whether to participate. The invitation emails could not be sent to all geotechnical engineers in the world, but to contact databases belonging to a number of organisations, which tended to be clustered in certain countries. Additionally, the response data is largely non-parametric (i.e. categorised) which does not lend itself to statistical analysis as readily as parametric data. However, the most important factor in determining the margin of error is the sample size: a sample size of 500 typically produces a margin of error of about 4.5%, a sample size of 1,000 typically about 3%, and a sample size in excess of 4,000 produces a margin of error of about 1.5% (American Statistical Association guide "What is a Survey").

Therefore, in this survey of 619 respondents, notwithstanding the bias that may be expected from a self-selecting sample, a margin of error of approximately ±4.5% would be expected.

3. Survey results – respondent details

The full results of the survey are presented in Appendix 2 in numerical form and in Appendices 3 and 4 in the form of charts, overall results and filter by countries, respectively. In this and the following chapters, the key findings from the survey are described. In some cases, readers should refer to Appendices 3 and 4 for a display of the results that are discussed below.

3.1. Respondent location

The respondent locations are shown in Figure 4 and Figure 5 and show a good geographical distribution of respondents across Europe as well as some significant representation from North America and other non-European regions.

The highest number of responses (12%) was received from North America and France, followed by Sweden and Germany with 11% of respondents, which, given Sweden's population of 9.5 million and Germany's 80.5 million, is remarkable and can be attributed to the invitation emails sent out by Skanska to the geotechnical community in Sweden.

Following Spain (10%) and United Kingdom (8%), the remaining countries contributed between 0.2 and 5% each of the total number of responses.

Some responses came from regions outside of Europe, such as North America (12%), Asia (4%), Australasia (4%), South/Central America (2%).

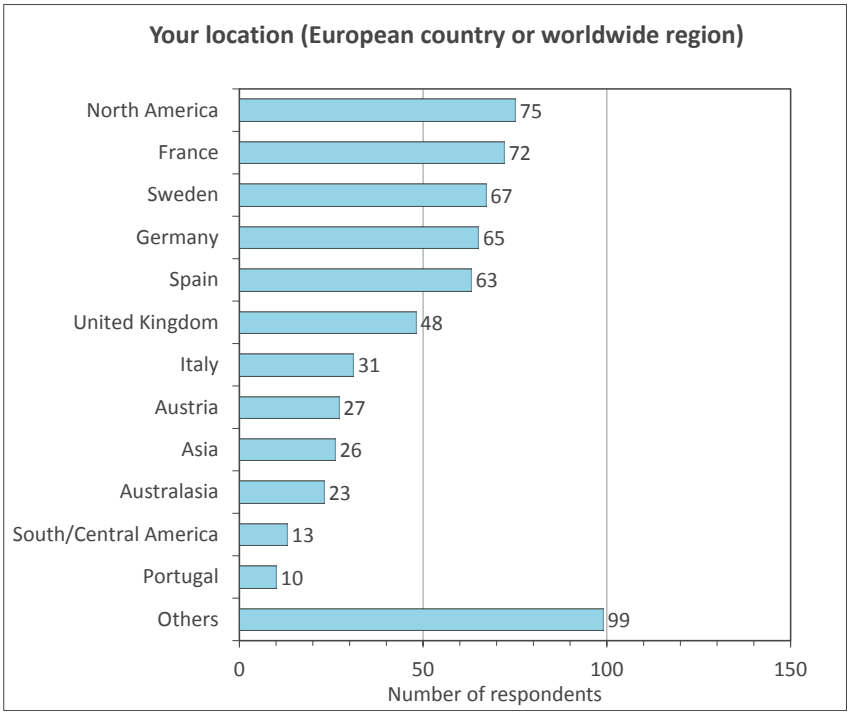

Figure 4 Location of survey respondents (by totals)

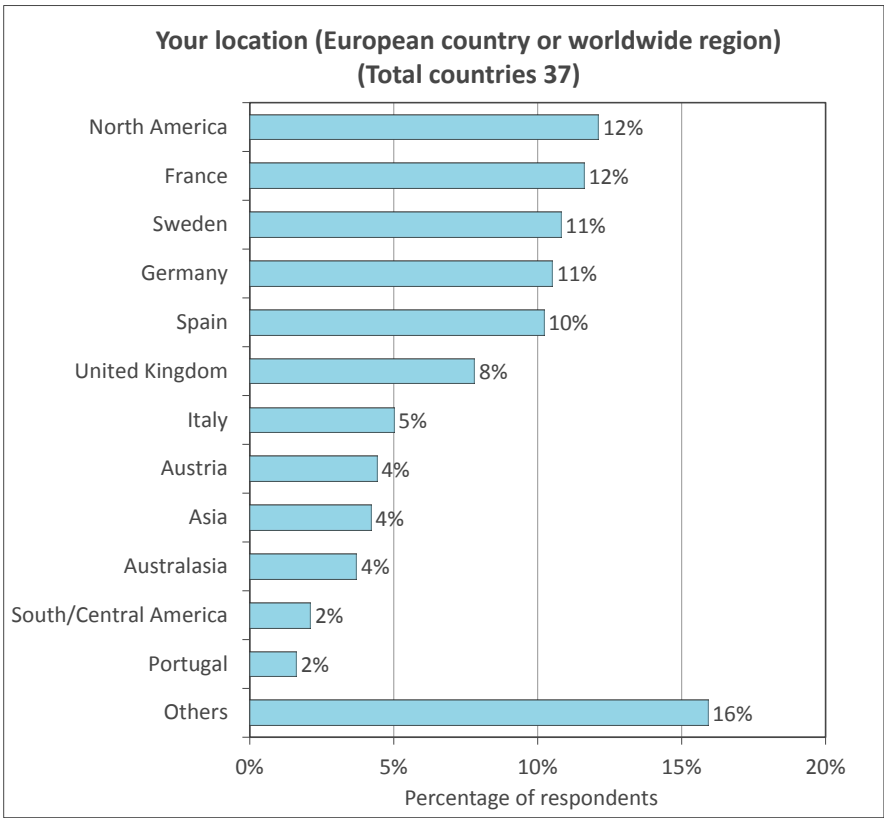

Figure 5: Location of survey respondents (%)

3.2. Respondent status

Respondents were well distributed across all age groups from 20 to 50+, with the most (35%) coming from the 30-39 age group.

The majority of respondents were engineers/analysts (30%), senior engineers (24%), and Academics (20%) while Directors (9%) and Project Manager (8%) were also well represented. Only a small proportion (5 %) was at technician/designer level however.

The educational level of about half the respondents was to EQF level 7 (master's degree) (48%), with 38% reaching EQF level 8 (doctorate) and 11% EQF level 6 (bachelor's degree). The high proportion of EQF levels 7 and 8 reflects the highly technical nature of the field of study and the need for specialised postgraduate study before implementing geotechnical numerical analysis tools in practice.

However, significant variation was recorded between countries, as shown in Figure 6. For example, France, Sweden and Spain recorded a high proportion (> 50%) at master's degree level and less (≤ 30%) at doctorate level, while about the opposite occurred in North America and United Kingdom (doctorate level > 50% and master's level ≤ 40%) and Germany had about the same proportion at each level at around 40%. These national differences could be a result of different qualification requirements to practice engineering in those countries as well as different cultures regarding the value of attaining the different levels of academic qualifications, and these differences should be borne in mind during the development of the COGAN deliverables.

Respondents were generally well experienced in geotechnical numerical analysis with 63% indicating over 5 years of experience (Figure 13), which enhances the value of the responses to the survey and reflects the specialised nature of these activities.

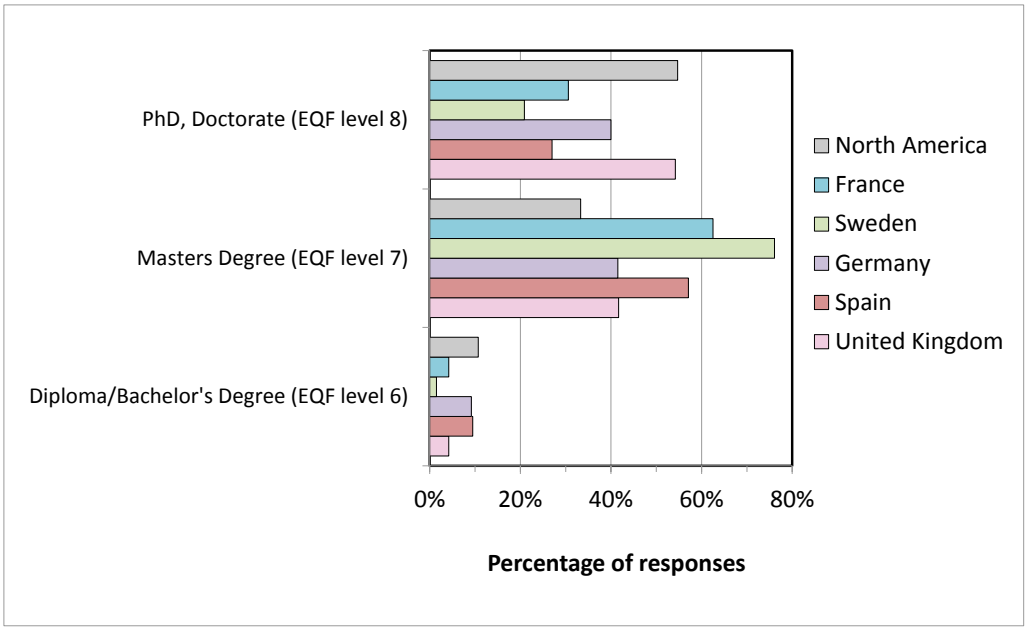

Figure 6: Education level of respondents (by countries)

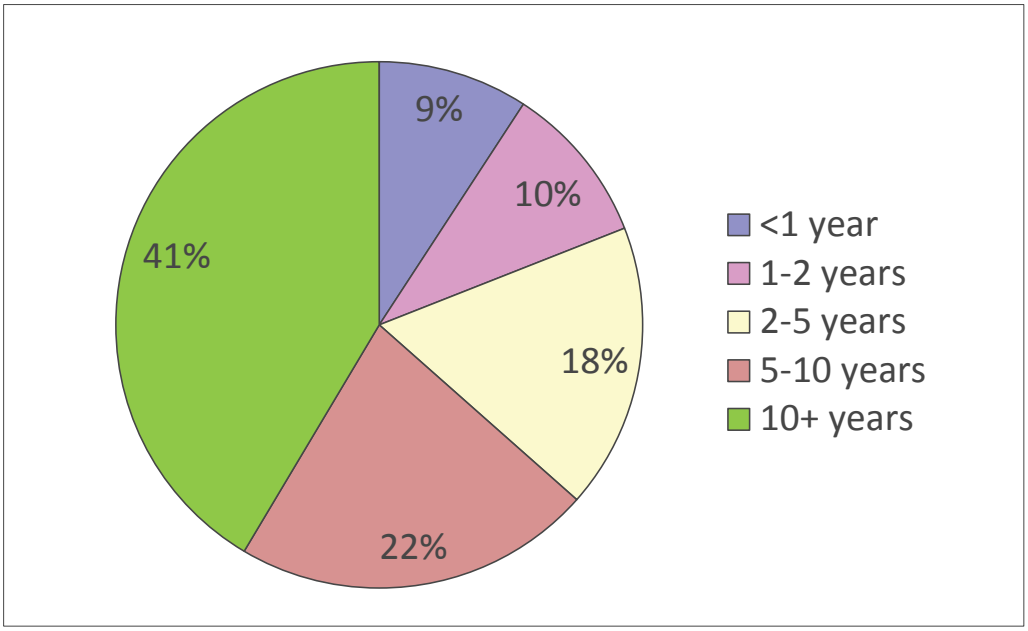

Figure 7: Experience in geotechnical numerical analysis

3.3. Respondents' engineering analysis activity

Figure 8 shows that about 70% of respondents spent less than 40% of their work time in the preceding 6 months involved in geotechnical numerical analysis. This suggests that the majority of users of numerical analysis software are part-time users, sharing their time between analysis work and, presumably, other geotechnical activities. In some respects this is good because of the importance of gaining all-round geotechnical knowledge and experience when performing numerical analysis, but in other respects the occasional usage of numerical analysis by many engineers presents a particular challenge in raising competency levels. It will be vitally important for the work-based training tools developed by the COGAN project to be flexible in order to fit around busy workloads and to be available on-demand when engineers undertake periods of activity in numerical analysis.

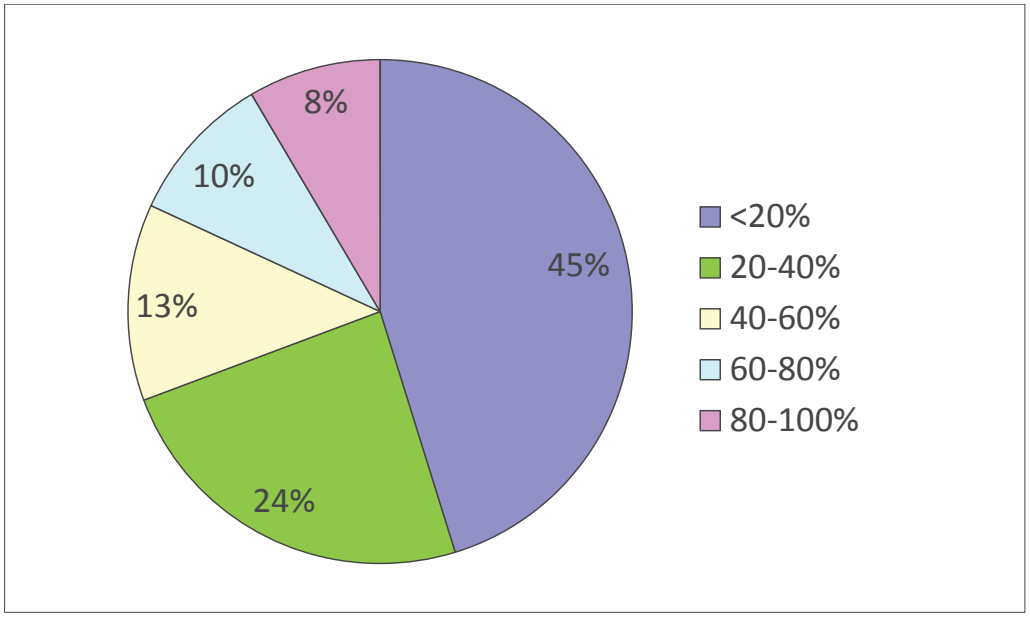

Figure 8: Proportion of work time spent in geotechnical numerical analysis in past 6 months

Respondents were asked how they felt their formal education related to their engineering analysis activity on a scale of 0 to 3 (Figure 9). About equal proportions responded with the intermediate levels of 1 and 2 (35% each), while 20% responded with 3 ("fully") and 11% responded "not related".

When analysed by education level, naturally those at a higher level felt that their formal education related more with their engineering analysis activity. Nevertheless, among even those holding a doctorate, only 34% felt that their formal education related fully with their engineering analysis

activity, so there is clearly a need for further work-based learning in geotechnical numerical analysis following academic studies before it is put into practice.

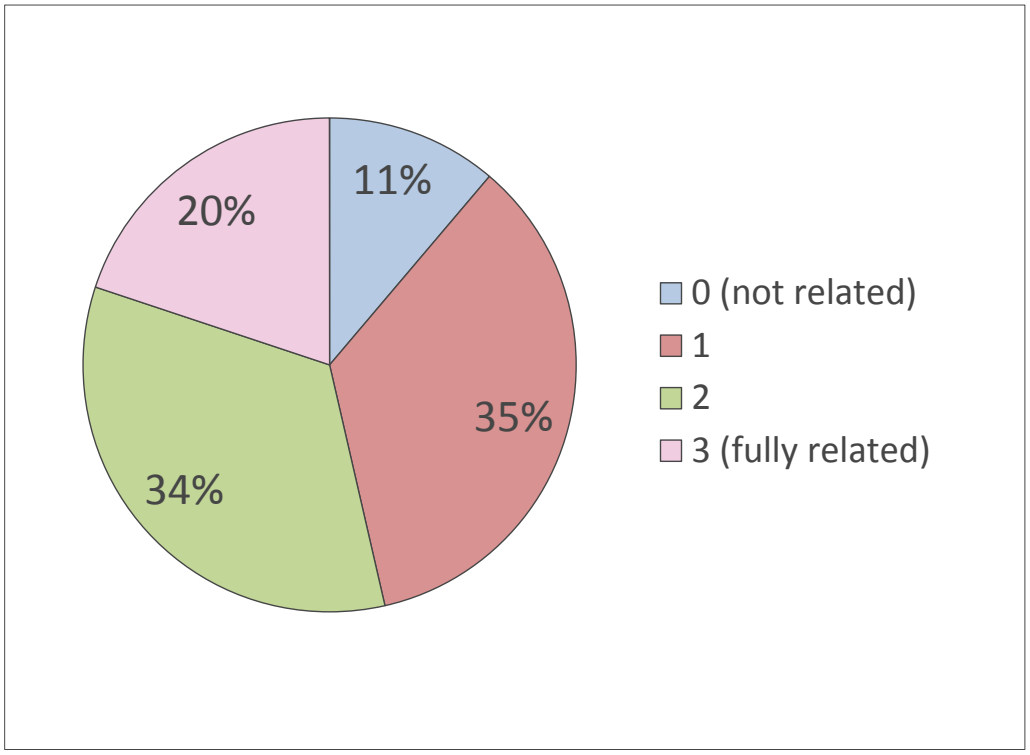

Figure 9: How formal education is related with current numerical analysis activity

4. Survey results – organisation details

4.1. Organisation activities

Figure 10 shows that the majority of respondents were employed in design offices/consultancies (61%) which is where one would expect the majority of numerical analysis use to occur in industry. This was followed by universities (24%), research and development (18%) and contracting (14%). Survey responses from universities were not excluded from this industry survey because many universities undertake a significant amount of consultancy work in addition to their academic activities and, in this respect, are likely to have similar training needs to industry.

Figure 11 shows four main geotechnical sectors, with:

i. 84% of all responses for Civil and Construction
ii. 25% of all responses for Mining
iii. 15% of all responses for each of Marine and Offshore, Oil and Gas.

As for the previous question, multiple selections were allowed so the percentages shown are based on the total sum of selections rather than the total number of respondents and the totals come to over a hundred.

Some interesting variations in geotechnical sector data occurred between location countries, as shown in Figure 12. Clearly, a huge majority (95%) of the responses in France, Sweden and Spain were for the Civil and Construction sector, while less so in the United Kingdom, Germany and North America. In these countries a greater share was taken by the Mining and Oil and Gas sectors and, in the UK, Marine and Offshore.

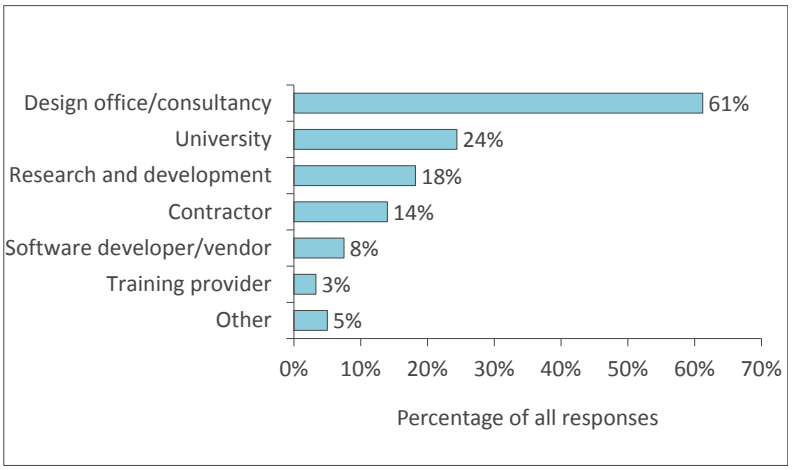

Figure 10: Nature of organisation

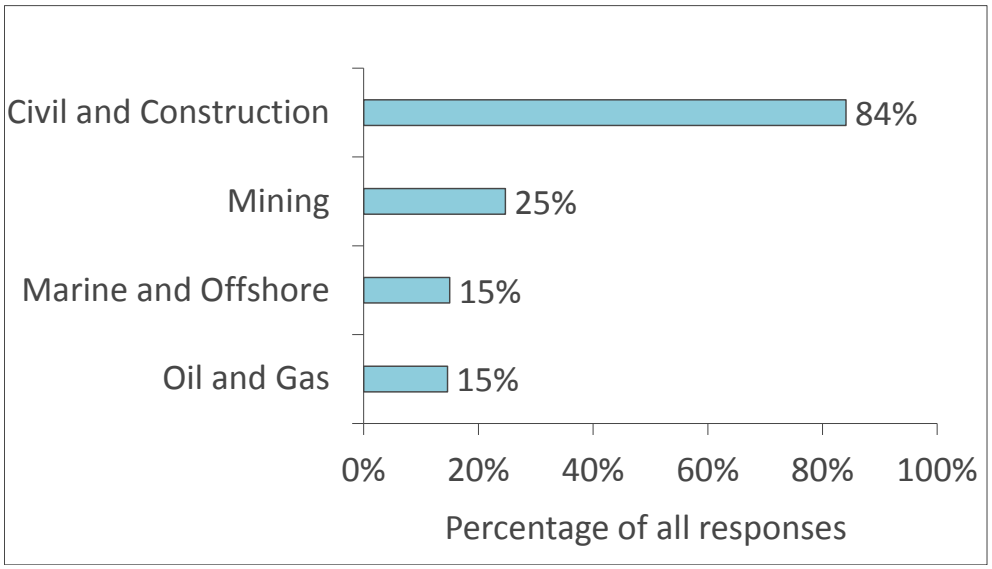

Figure 11: Industry sector of organisations

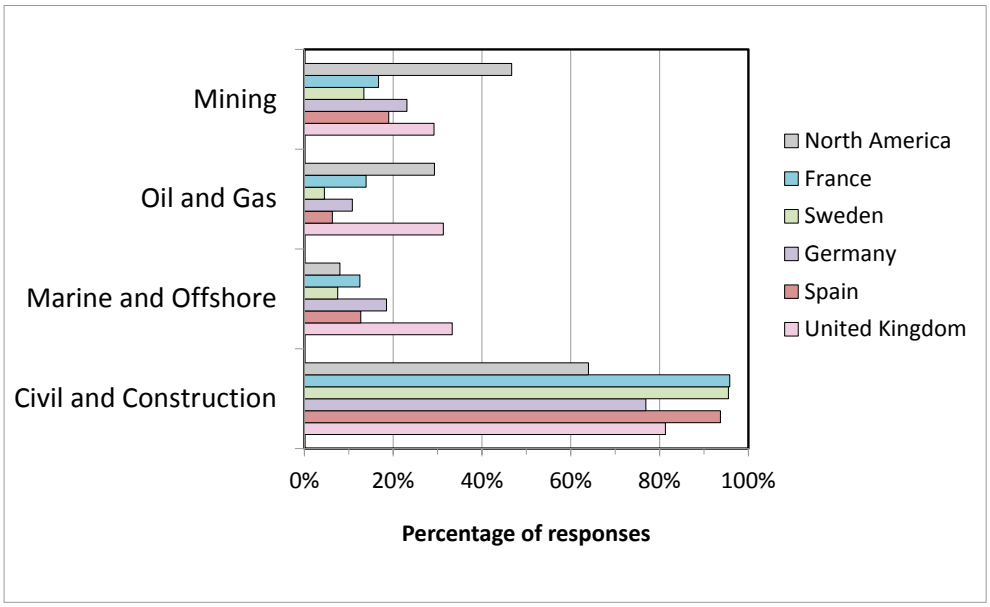

Figure 12: Industry sector of organisations (by country)

4.2. Size of organisations and engineering analysis

A third of the respondents to the survey worked at large organisations (500+ employees) while a significant proportion (24%) worked at very small organisations of 1-20 employees. The proportion of respondents working in organisations falling into the SME category (up to 250 employees) was 60%, so both large organisations and SMEs were well represented in the survey.

Respondents were also asked to state the number of engineering analysts working in the organisation. The data shows that 45% responded with 1-5 analysts, 25% responded with 6-10 analysts, 27% had 11-100 analysts and only 4% had 100+ analysts. The significant proportion of respondents working in groups as small as 1-5 users of numerical analysis software, together with the high likelihood that even they might be part-time users (as suggested by responses to an earlier question) illustrates the challenge in raising the competency level of engineers in organisations that have not accumulated a significant body of expertise in this field. With a lack of in-house expertise, many engineers will be in need of accessible, external day-to-day training resources.

4.3. Organisation engineering analysis activity

Respondents were asked to indicate the type of numerical analysis software employed in their organisations and were free to select multiple categories (Figure 13). The most selections (82%) were for "commercially available with standard material models provided with software", then "commercially available with user-defined material models" (53%), "wholly developed in-house" and "commercially available with in-house modifications" software accounted for 29% and 19% of selections respectively. "Open source" accounted for 12% of selections and "external development/tailoring" for 5%. No particular trends in the data were observed between countries.

Therefore, it can be summarised that 80% of respondents use commercially available software and, understandably, the proportion was higher among commercial organisations (design offices and contractors) at 87%, while universities had a higher proportion of in-house software usage (38%). These figures provide useful insights into the nature of numerical analysis software use in practice.

Respondents were asked to state the proportion of their analysis time spent using different numerical methods. The data shows, on average, 49% use of the finite element method (FEM), 18% on finite difference method (FDM), 13% on discrete element method (DEM), and 20% on "other numerical methods".

Respondents were also asked how their organisation's geotechnical activities were shared between "Soil Mechanics" and "Rock Mechanics". On average, 66% of activities were in soil mechanics and 34% in rock mechanics fields. That is in line with the previous question because the majority of respondents use FEM and FDM which are more associated with soil mechanics problems.

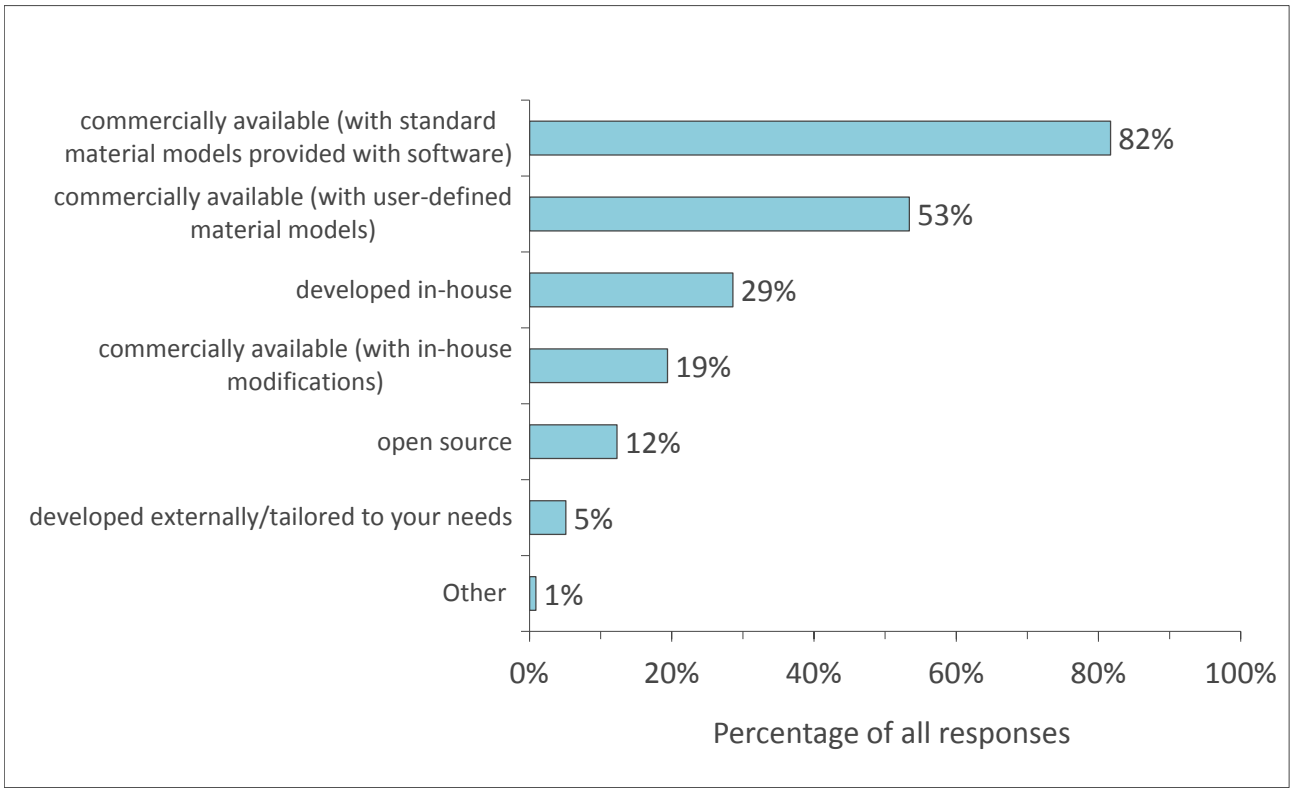

Figure 13: Software types used by organisations

4.4. Issues concerning the use of geotechnical numerical analysis

Respondents were asked to rate a number of issues concerning the use of geotechnical numerical analysis software in industry, on a scale of 0 (not an issue) to 3 (serious issue), and the average ratings are shown in Figure 20. The four highest ranking issues were "validation of analysis results", "obtaining soil/rock parameters", "lack of money/time for training", and "poor access to in-house experts or no mentoring system". The first two relate to the need for geotechnical engineers engaged in numerical analysis to have a good all-round knowledge of geotechnical engineering in order to bridge the gap between reality and the computer model by obtaining parameters from real-world tests for idealised soil models and by checking that analysis results are a sufficiently accurate representation of reality. These issues place perhaps the heaviest demands on the competency of engineers because they need to understand both the computer model and the background geotechnical engineering. Therefore, it will be necessary for the COGAN Educational Base to include modules on the background geotechnical knowledge needed to perform numerical analysis, as well as to cover the specific areas of validation and obtaining parameters. The third is an issue for many organisations and can be addressed by more high-quality and engaging e-learning courses that can fit around people's workload rather than add to it – a need that should be met by the COGAN Exemplar E-Learning Modules and which can then be developed into more courses by training providers beyond the life of the COGAN project. The fourth ranked issue is particularly concerning and probably arises from the earlier observation of the small number of users of numerical analysis software leaving some organisations unable to establish a critical mass of expertise to provide in-house mentoring. This again shows a clear need for the COGAN deliverables which should help to raise the competency level of these small groups of engineering analysts by providing affordable, accessible training resources.

Across the different countries (see Appendix 4), the trends were similar to those shown in Figure 20 for all responses.

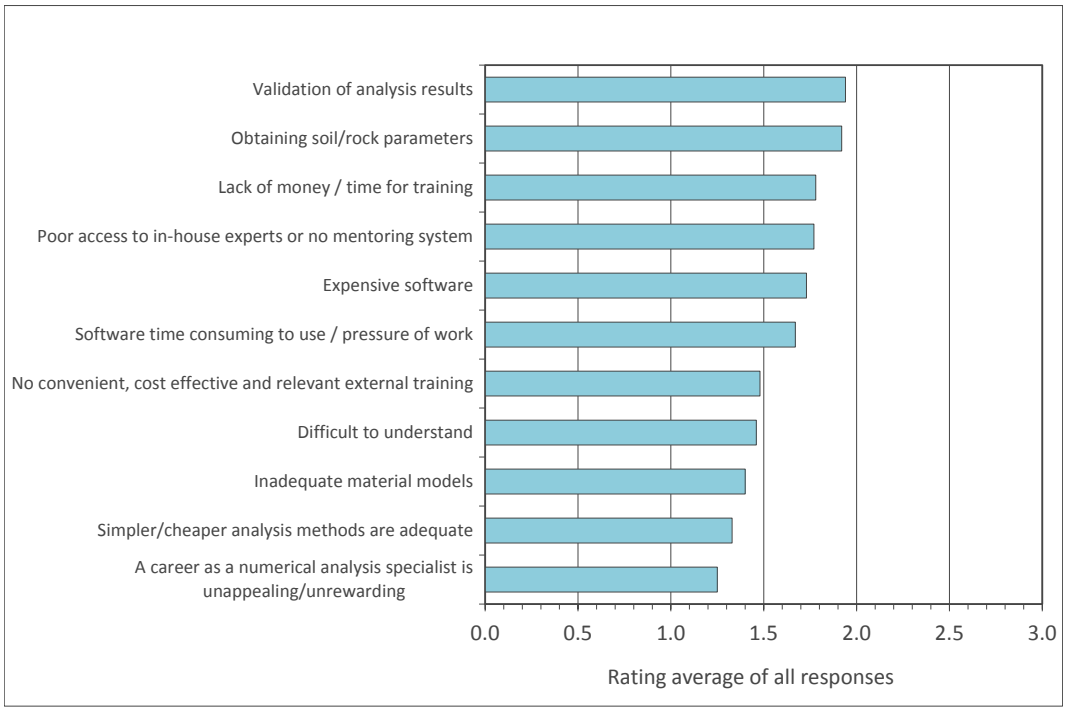

Figure 14: Issues concerning the use of geotechnical numerical analysis in industry

4.5. Any existing definition or recording of analyst competences?

Respondents were asked two simple "Yes/No" questions on current practices in their organisations regarding analyst competences. The first asked whether the competences needed to perform different geotechnical numerical analysis tasks are formally defined and the response overall was 62% "No". This shows that there is a significant need for the educational base being developed in this project.

The second question asked whether there is a system for looking-up and recording staff competences in geotechnical analysis and simulation. A significant majority (73%) responded "No", which demonstrates the need for the COGAN competency framework.

Interestingly, the responses to these two questions were not particularly dependent on organisation size or number of analysts, so the lack of definition of competency is perhaps not resource-driven but an industry-wide issue. However, there was some variation by country, as shown in Figure 22, with a higher proportion of organisations with existing systems in both France and UK.

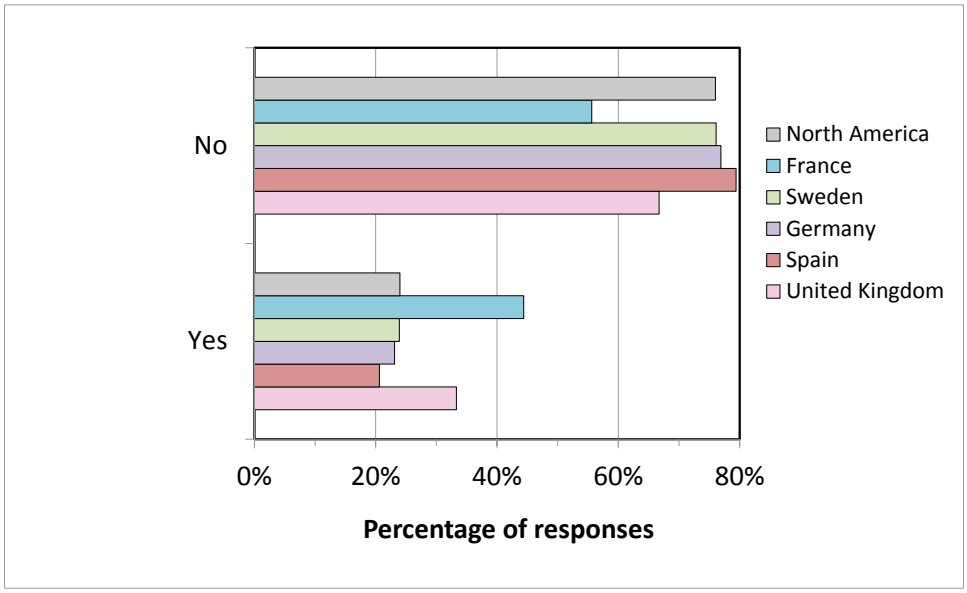

Figure 15: Does a system to record analyst competences exist in your organisation?

5. Survey results – existing systems to record analyst competences

The 168 (~30%) respondents who selected "Yes" in the question asking whether a system to record analyst competences existed in their organisation were asked three additional questions about their systems in order to help ensure that the COGAN Competence Framework can interface with existing systems more easily.

The media employed by companies for such systems are shown in Figure 16. Paper based and company intranet are clearly the most common (53% and 51%, respectively) followed by commercially available software systems (24%) (multiple selections were possible in this question).

The number of skill levels used in existing systems is shown in Figure 17. It appears that 33% of existing systems have no definition of skill levels, while among those systems with skill level definition, three levels is the most common at 27%.

Finally, respondents were asked to select the method of assessment employed to assess whether engineers have achieved the competences defined in the system (multiple selections were allowed). By far the two most common assessment methods were "internal assessment by manager/mentor" and "self-assessment", both at 62%.

Figure 19 shows the assessment methods by countries where there are interesting differences in culture. Spain, for example, rated self-assessment much lower at 36% and external assessment higher at 43%, while Germany and UK appear to use more self-assessment. It will be important for the COGAN deliverables to have the flexibility to accommodate these cultural differences.

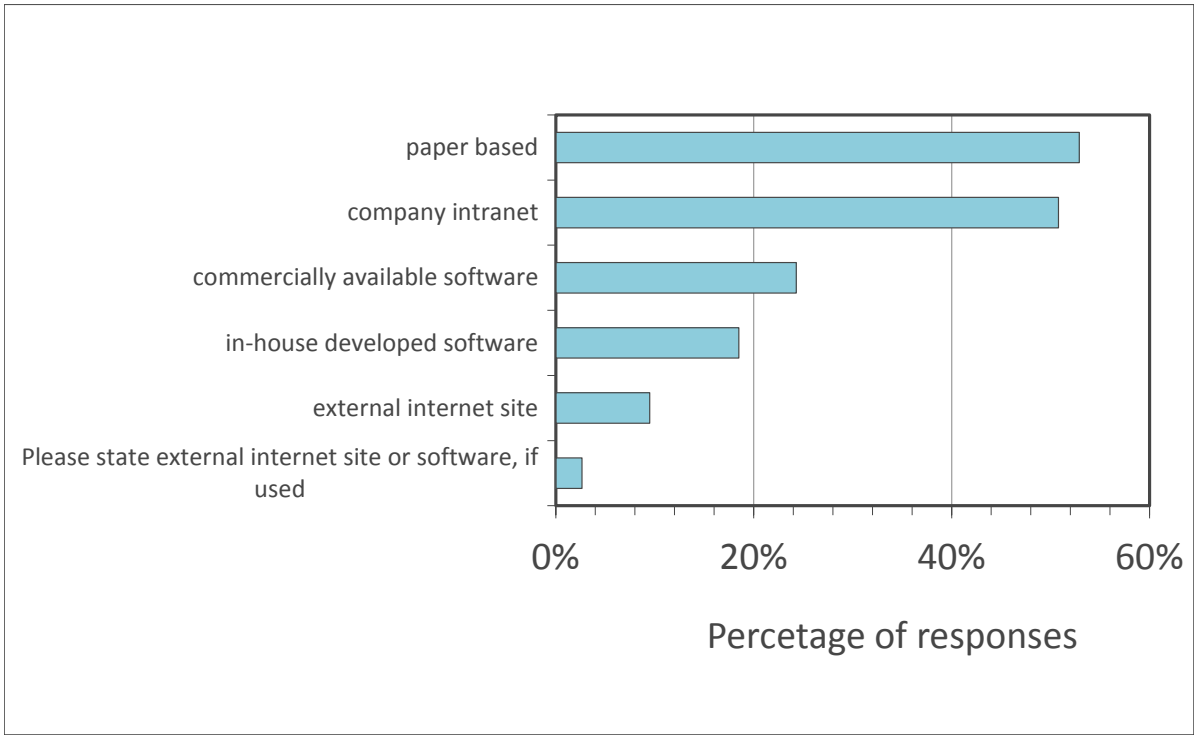

Figure 16: Medium for existing systems of recording analyst competences

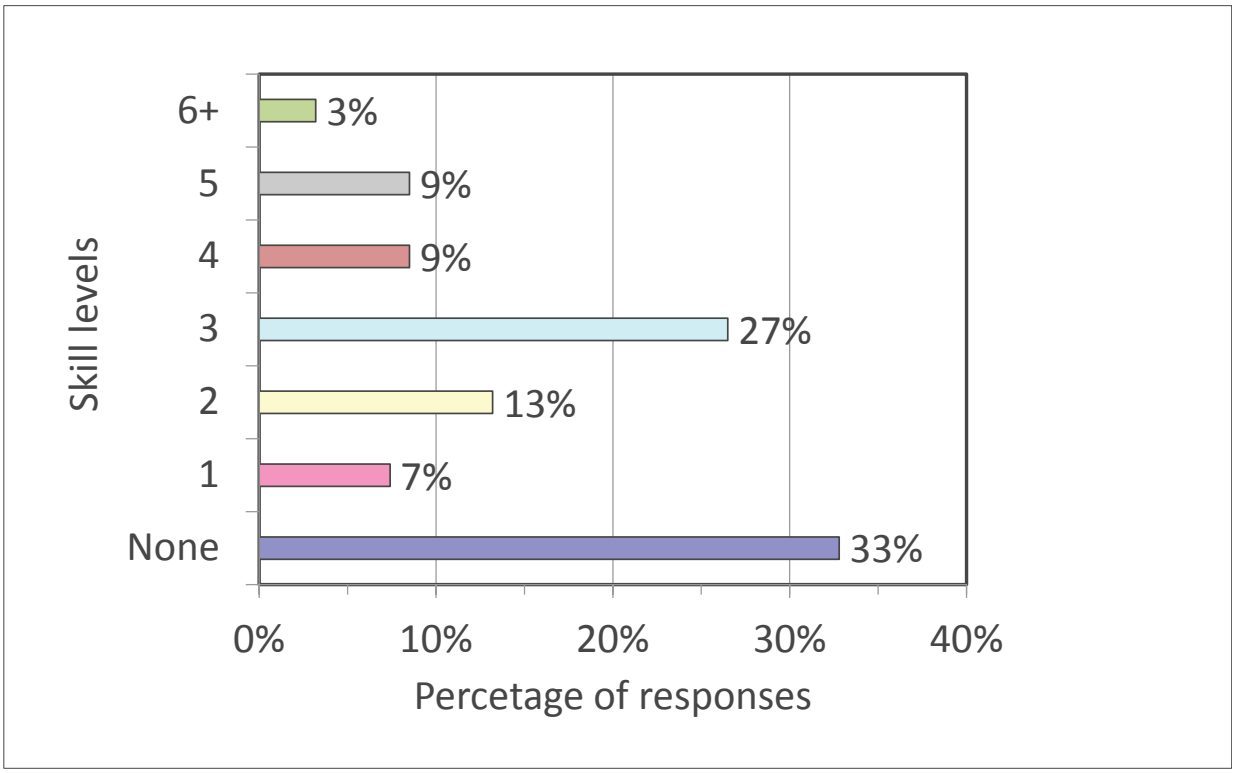

Figure 17: Number of skill levels employed in existing systems for recording analyst competences

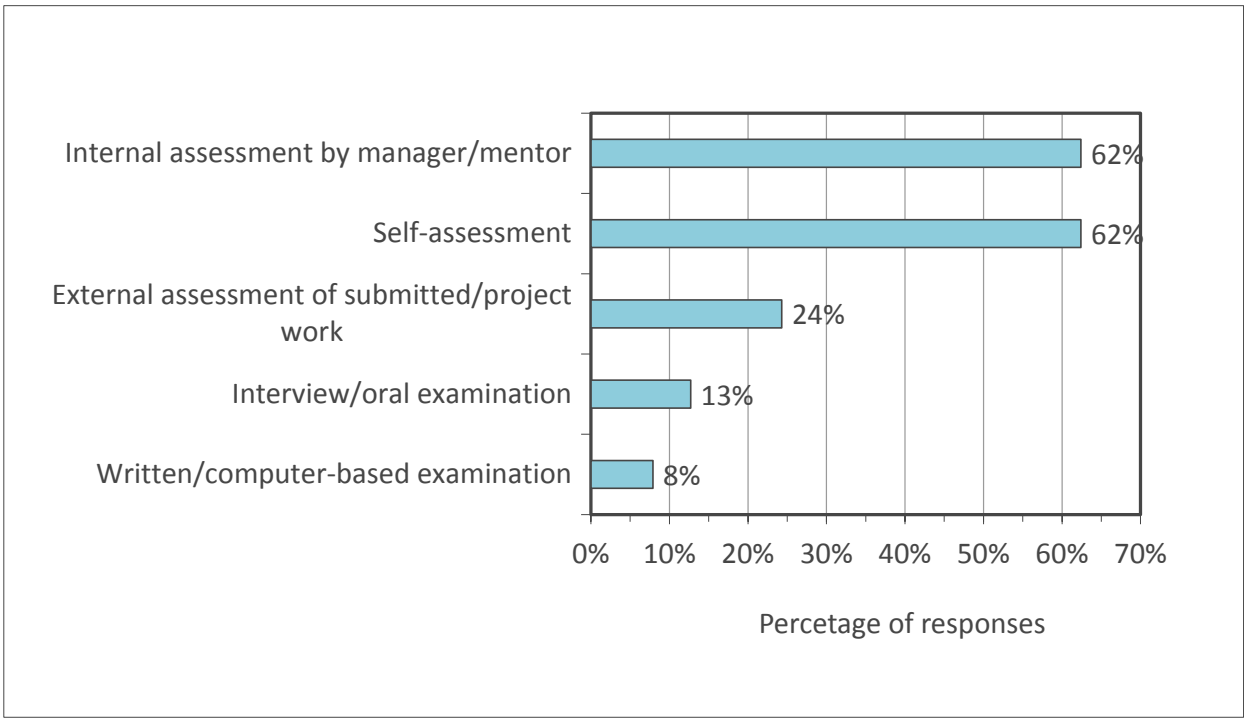

Figure 18: Assessment methods employed in existing systems for recording analyst competences

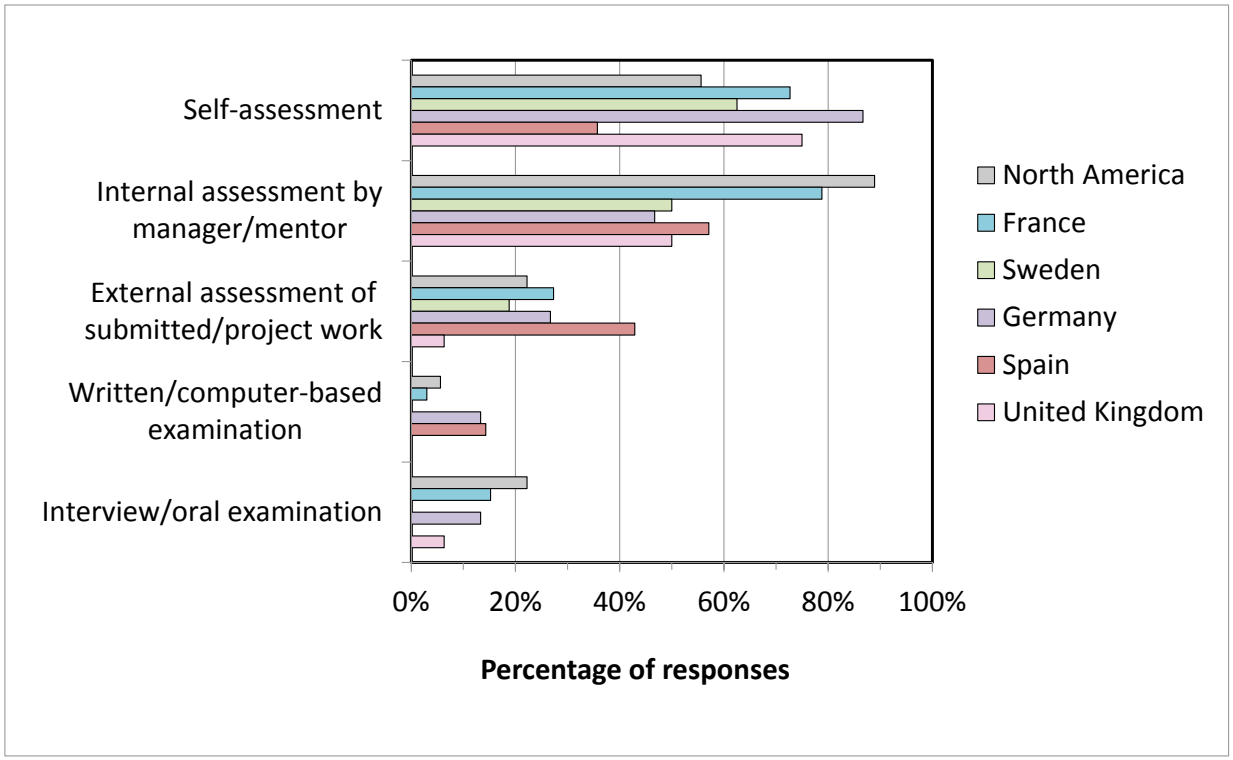

Figure 19: Assessment methods employed in existing systems for recording analyst competences (by countries)

6. Survey results – ideal system to define and record analyst competences

All respondents were then asked for their preferences for an ideal system to define and record competences. The responses to these questions are described in this section.

6.1. Good idea?

When asked whether a system that defines competences in geotechnical numerical analysis and provides links to appropriate training resources would be useful for professional development, a large majority (85%) responded "Yes", which shows that there should be enormous interest in the outcomes of the COGAN project.

Respondents were also asked to state any systems they were aware of outside of their organisation for defining and recording analyst competences. The full list of responses is provided in Appendix 2 (Q22), but no existing suitable systems were identified.

6.2. Preferred medium and number of skill levels

As in the previous section concerning existing systems, respondents were asked for the preferred medium and number of skill levels their ideal system, and these responses will be used to guide the development of the COGAN competency framework. As shown in Figure 20, the preferred medium is a secure website, followed closely by company intranet.

The preferred number of skills levels, as shown in Figure 21 and Figure 22, are '3' then '4', and '3' was also the most popular selection in existing systems that had skill levels defined, as described in the previous section. It was thought that perhaps director-level survey participants may prefer more levels and junior engineers fewer levels, but the results compared between positions within organisations are shown Figure 32 and clearly 3 levels is the preferred choice by all.

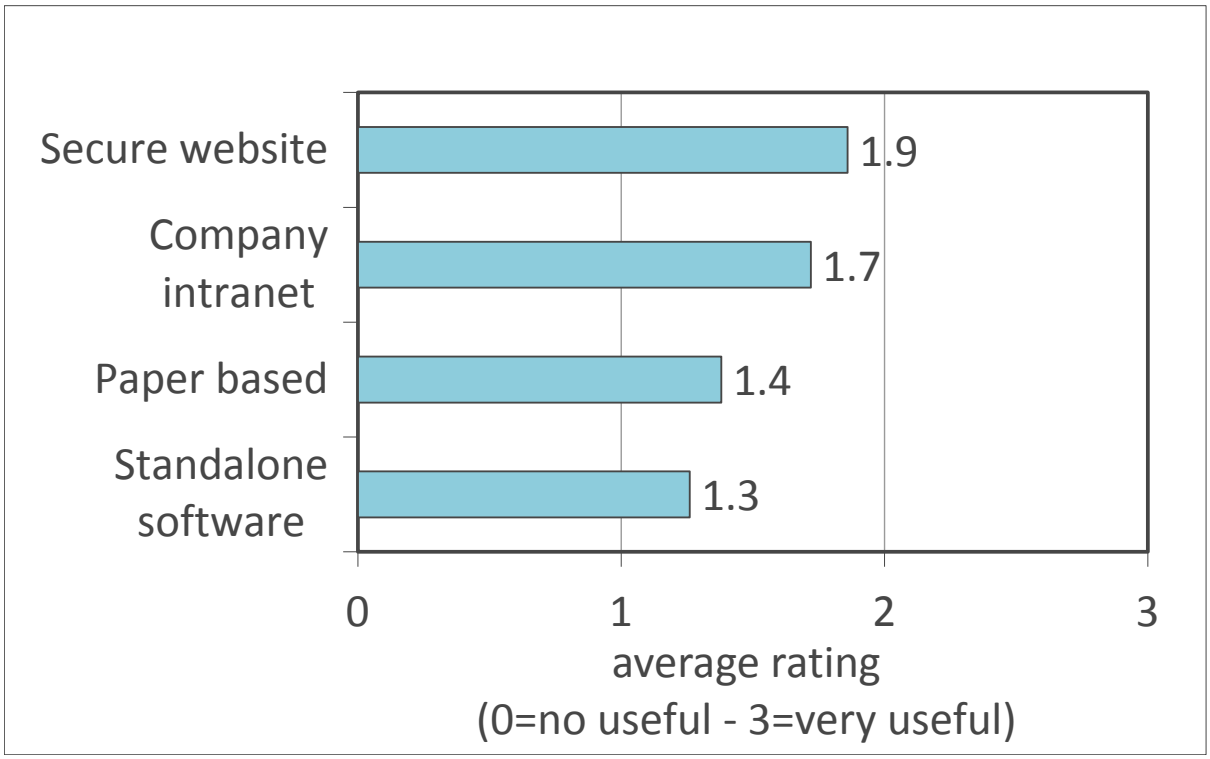

Figure 20: Preferred medium for recording analyst competences

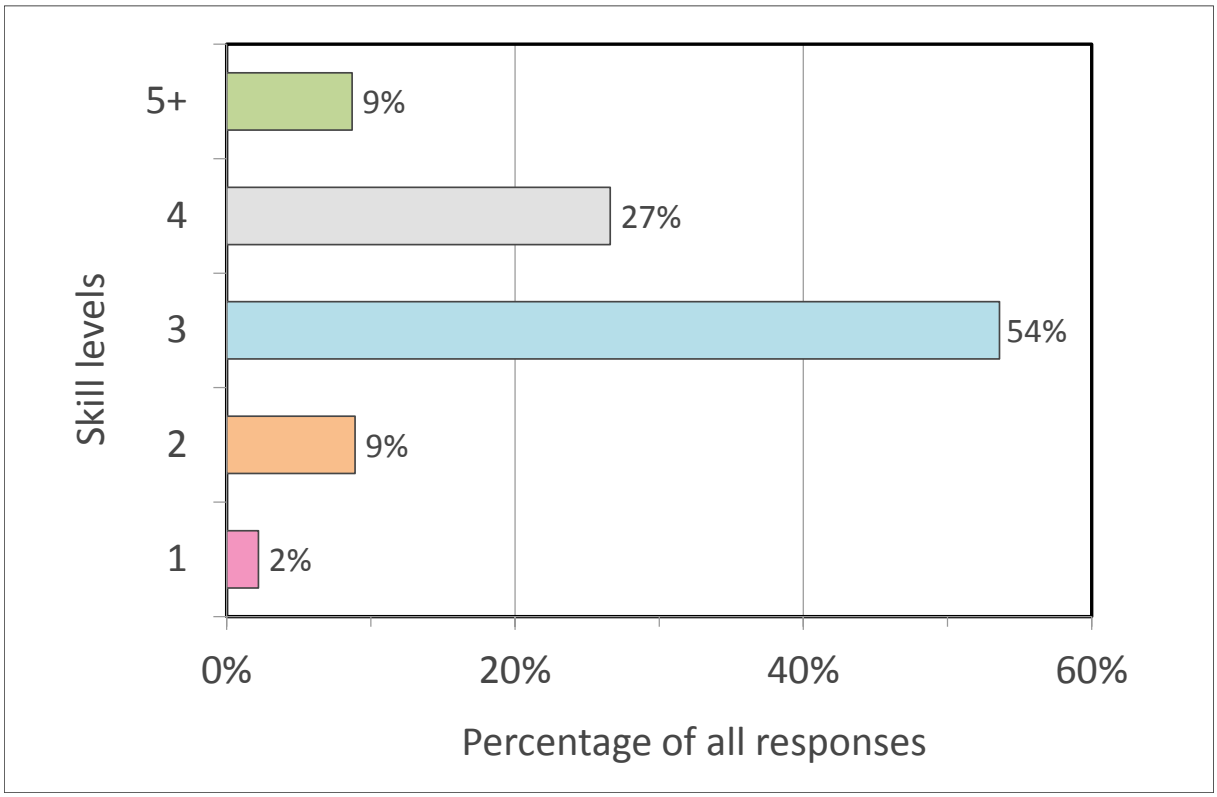

Figure 21: Preferred number of skill levels for recording analyst competences

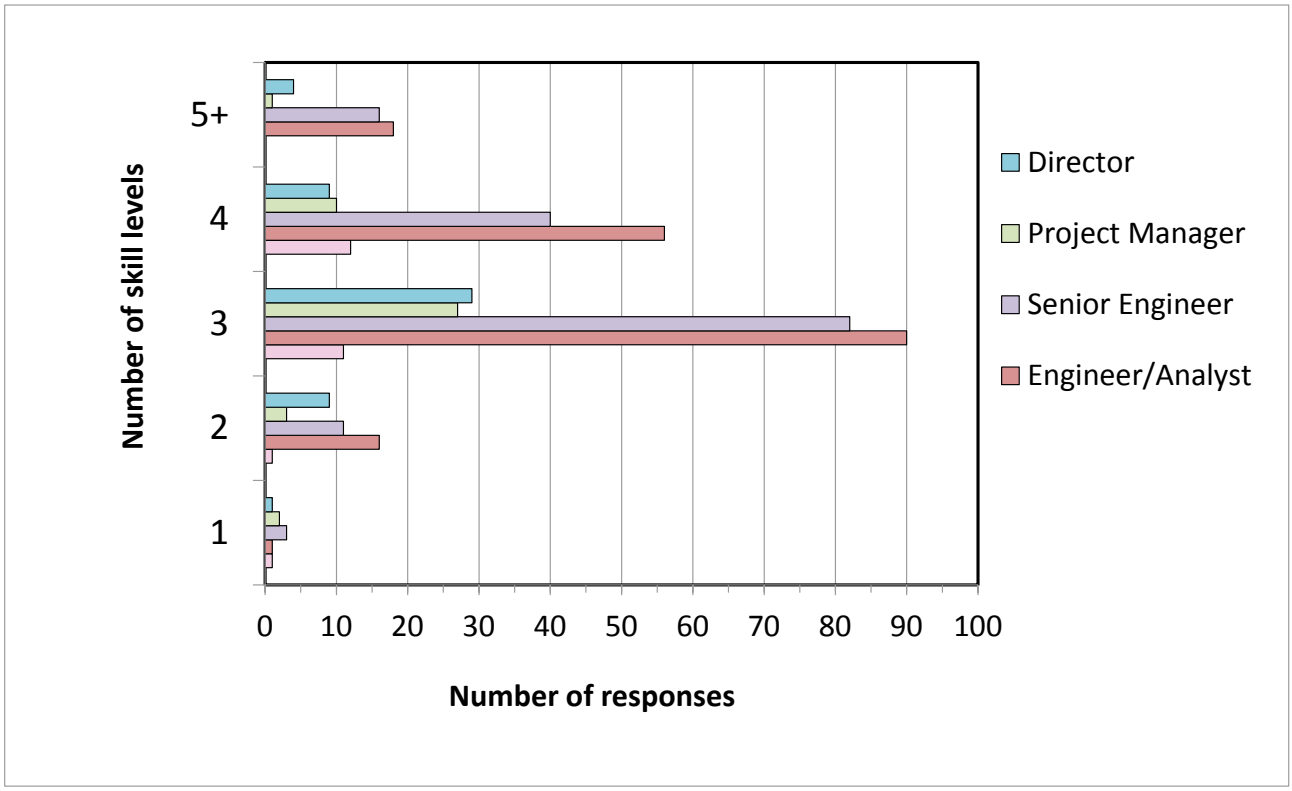

Figure 22: Skill levels filtered by seniority

6.3. Analysis areas

To help draw up the list of competence modules in the Educational Base, respondents were asked to rate the importance of defining the competency of a list of analysis areas. The average rating of each of these is shown in rank order in Figure 33. The two highest ranked areas were obtaining parameters and validation, which were also flagged up as serious issues in an earlier question, reaffirming the need for improved competency in these areas.

Respondents were also asked whether the competence statements should be focussed on background geotechnical knowledge, or generic, structure-specific or software-specific analyses. Background knowledge was ranked the highest (see Figure 34), reflecting the importance of a broad geotechnical knowledge when performing geotechnical numerical analysis. Consequently, the COGAN Educational Base will include modules on the background geotechnical knowledge required to perform effective numerical analysis. Structure-specific and generic analysis were also ranked highly. Consequently, the Educational Base should contain modules in background geotechnical knowledge and structure-specific applications as well as in the generic areas originally proposed. This might be at the expense of some of the lower-ranked areas shown in Figure 33. A software-specific focus was the lowest ranked but still indicating strong demand for software-specific competence statements, perhaps providing motivation for software vendors to develop their own software-specific competences to add on to the non-software-specific competence statements of COGAN.

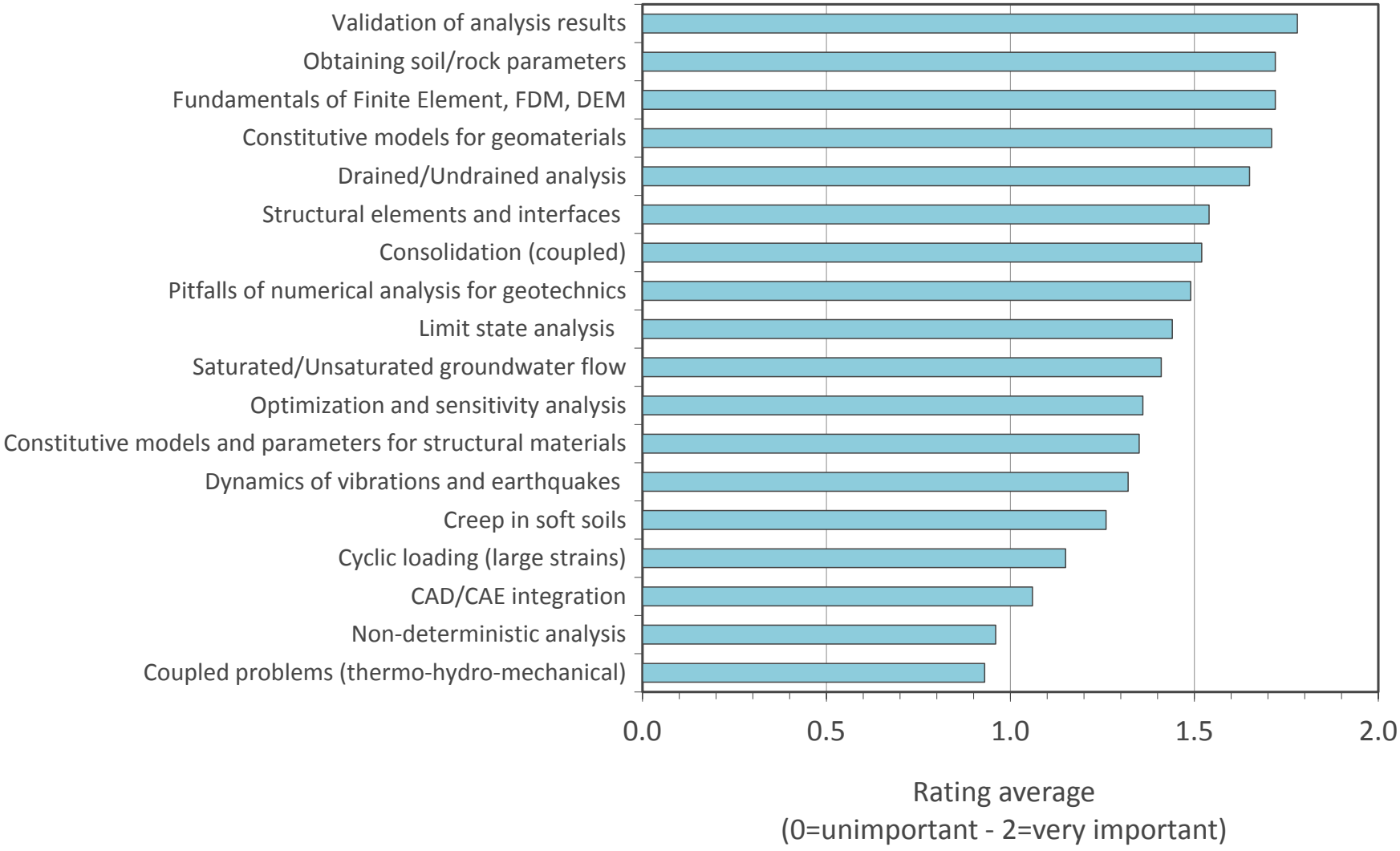

Figure 23: Importance of analysis areas for definition of competency

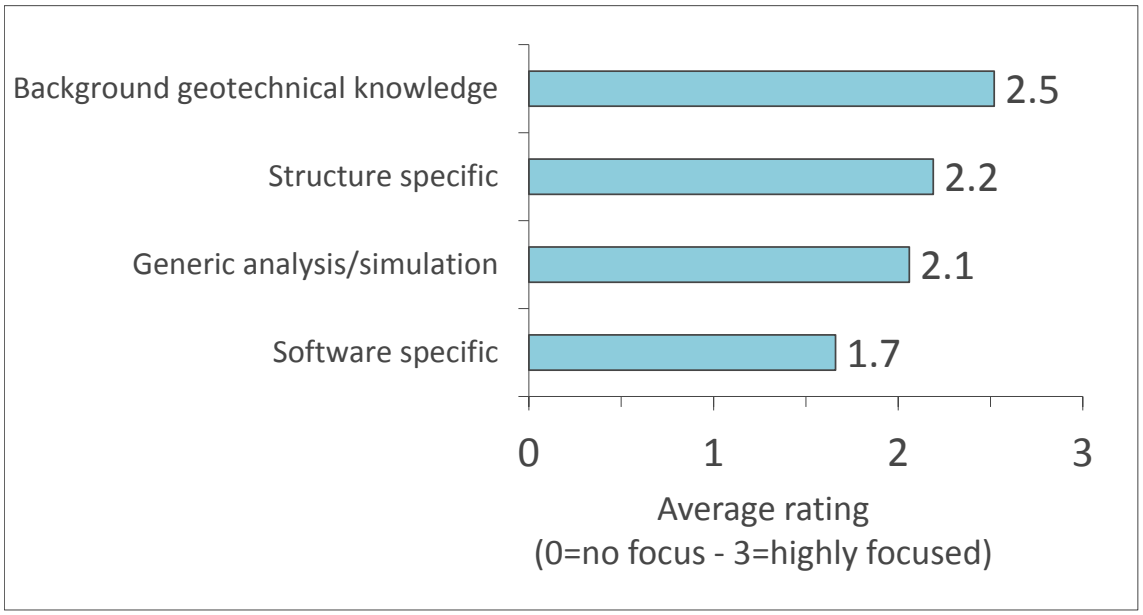

Figure 24: Preferred areas of focus for competency statements

7. Survey results – training needs

7.1. Learning methods and e-learning modules

Respondents were asked to rate the usefulness of various learning methods on a scale of 0 to 3 where 0 = not useful and 3 = very useful. On-the-job training or mentoring was ranked as the most useful (along with face-to-face courses), which makes it all the more disappointing that access to mentoring was ranked as a major issue in an earlier question. To help address the issue of a lack of mentors and in-house expertise, the COGAN deliverables should give more structure to on-the-job learning and provide a bigger pool of competent engineers to provide the mentoring. Similarly, the Educational Base and Competency Tracker should help to give more structure to face-to-face courses so that they complement the other learning methods.

It was interesting to note that a high proportion of respondents (23%) had no experience of e-learning courses in geotechnical numerical analysis (see Figure 36), reflecting the paucity of e-learning material currently available. The average rating of these learning methods was a little lower at 1.5, but still apparently valued by many who have had experience of them. They are also a requirement in order to address the issue of access to affordable training.

Finally, respondents were asked to vote on the fields of geotechnical numerical analysis that they would like covered by the two COGAN e-learning modules. Following a common thread through the survey, the most popular areas were fundamentals of FEA, FDM, etc., constitutive models, obtaining parameters and validating analyses, as shown in Figure 37. These results will help the project partners to select appropriate topics, but the final decision will be deferred until the draft Educational Base has been completed.

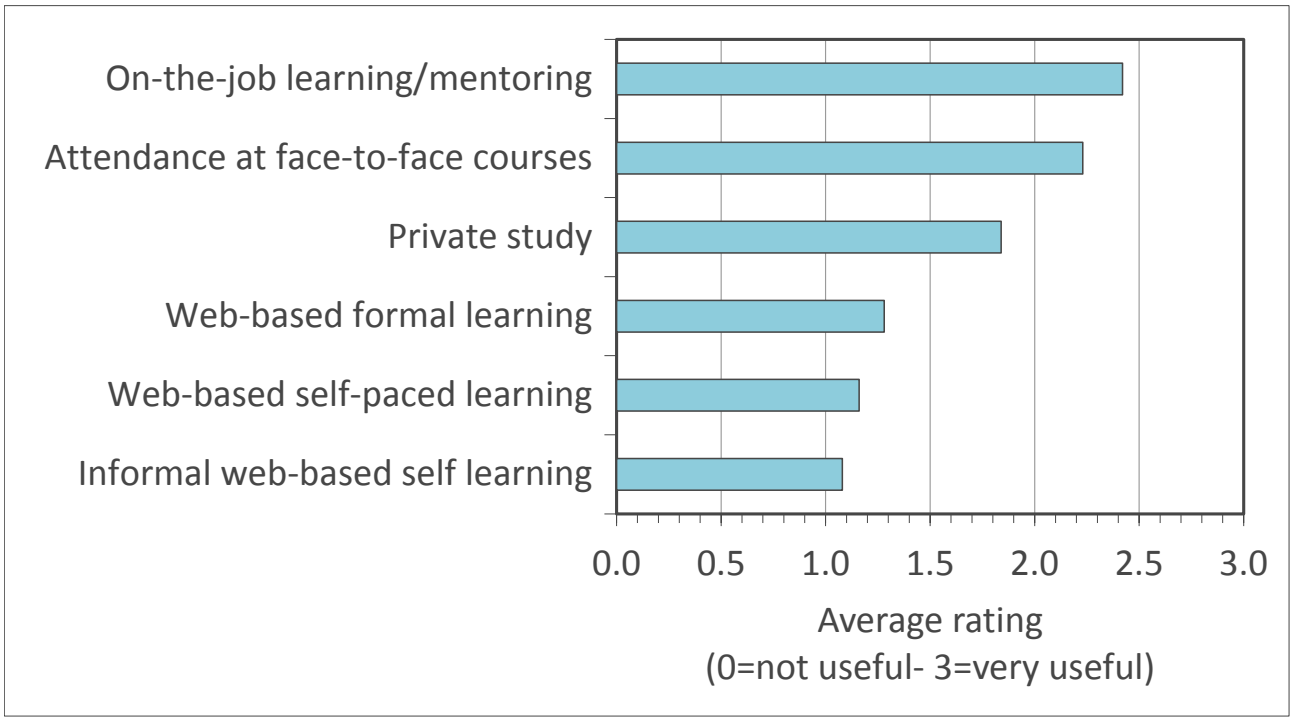

Figure 25: Usefulness of learning methods

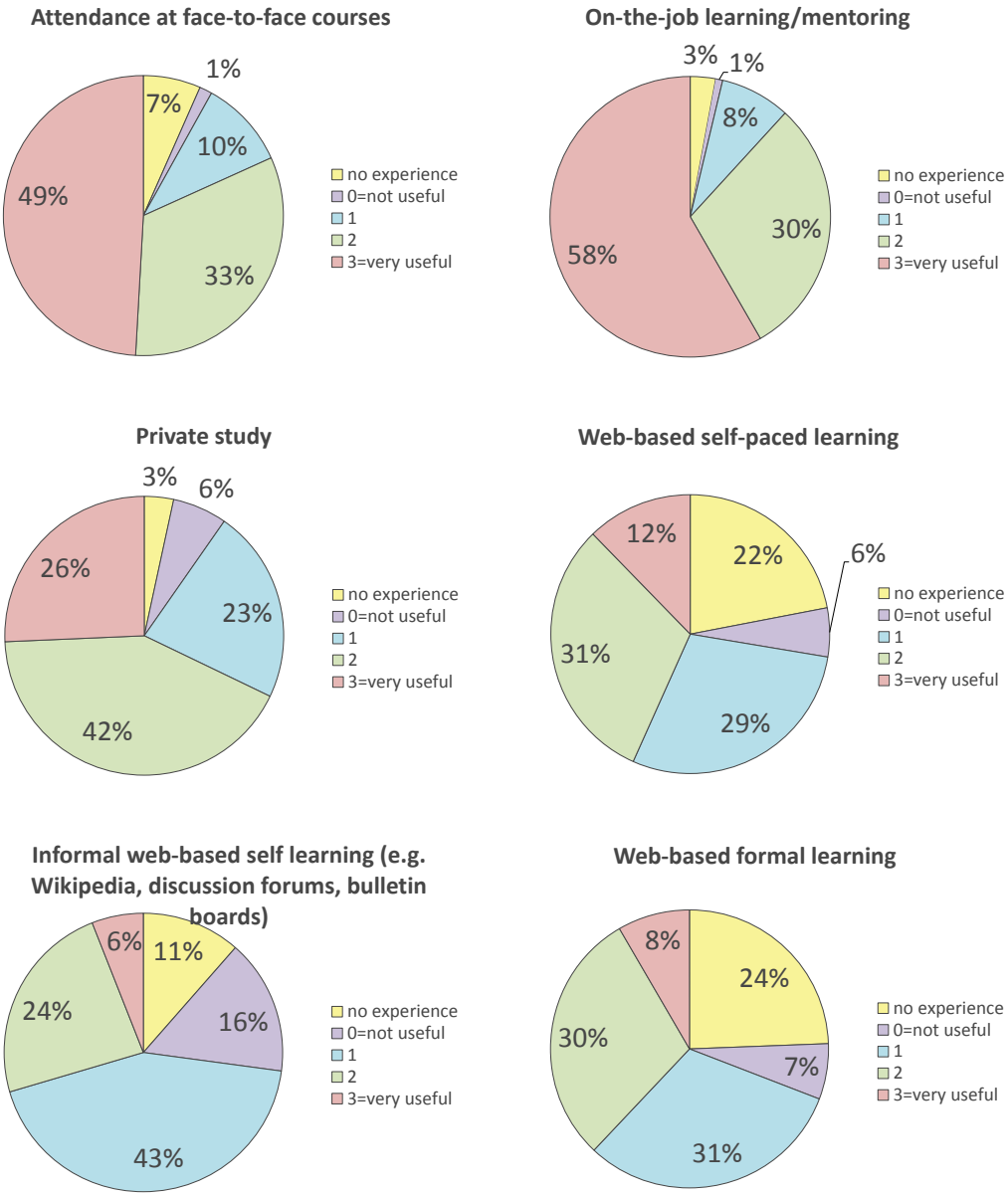

Figure 26: Usefulness of learning methods

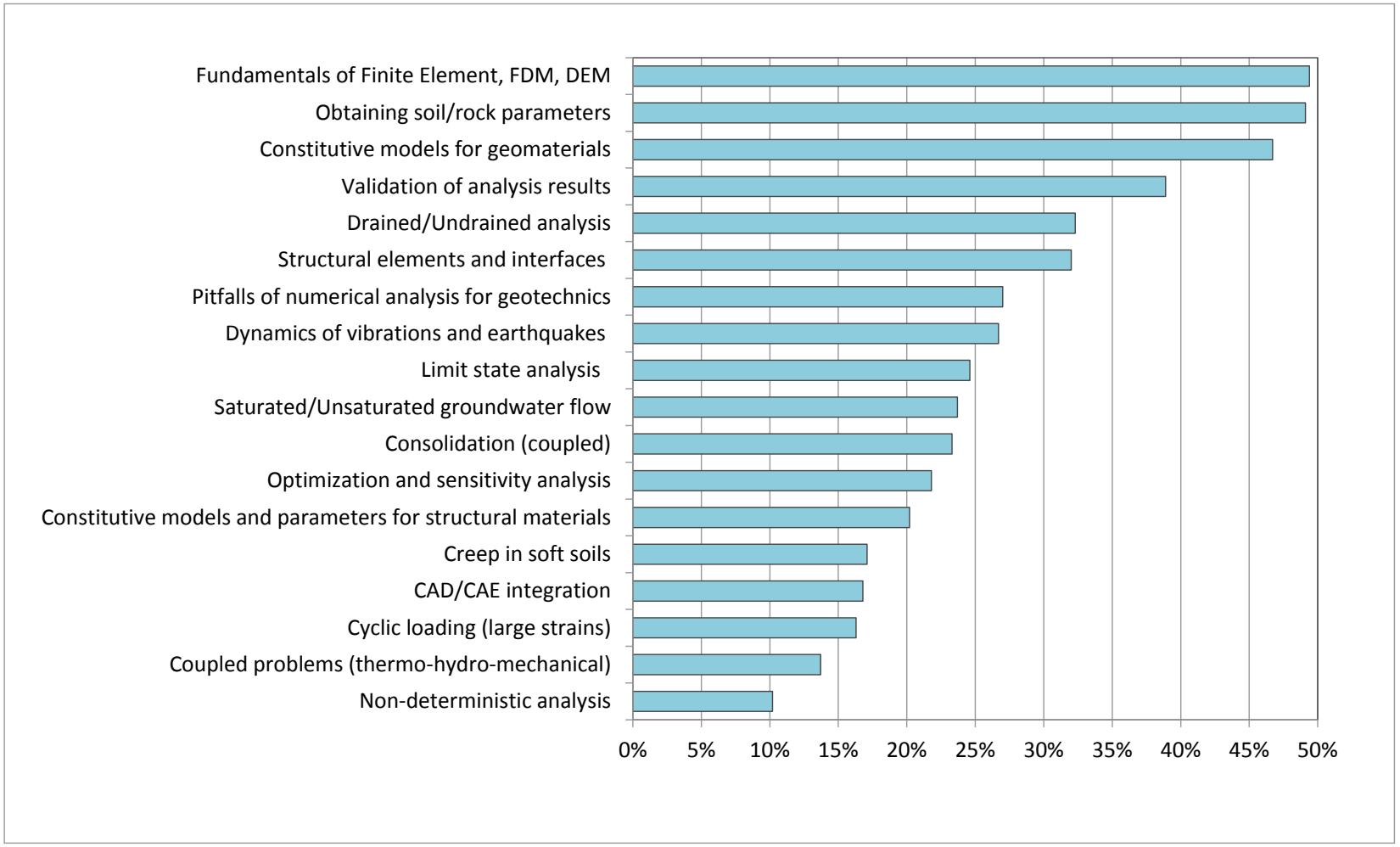

Figure 27: Popularity of potential topics for the COGAN e-learning courses

8. Survey results – additional comments by participants

In the penultimate question, participants were asked whether they would be willing to evaluate some of the COGAN deliverables later in the project. More than half (57%) responded "Yes", illustrating the high level of interest in this project.

At the end of the survey, respondents were invited to provide any additional information concerning the survey that could not be expressed in the preceding questions. 80 respondents did so and their comments are listed in Appendix 2 (Q30). The vast majority of the comments either reinforced the need for the COGAN project through participants' concerns regarding competency in geotechnical numerical analysis or expressed support for the goals of the COGAN project.

9. Conclusions

1. The COGAN industry needs survey was completed successfully with all metrics exceeded. A wide geographical distribution of responses was obtained, together with a good cross-section of ages and seniority. Most responses were from design offices and consultancies, but contractors, universities and other research and development organisations were also well represented, as well as SMEs with 60% falling into this category (less than 250 employees).
2. The large number of responses (619) and wide geographical distribution confirmed that there is strong Europe-wide interest among geotechnical numerical analysis users for greater staff development, a competency tracker and new training material.
3. The majority of respondents have high education levels (86% at EQF 7 or 8) and experience levels (63% at 5+ years), confirming the specialised nature of geotechnical numerical analysis and the need for postgraduate formal study before beginning to apply these tools in practice.
4. Responses to some of the questions confirmed that there exists a significant need in industry for the deliverables of the COGAN project. For instance, only 34% of respondents educated even to doctorate level considered that their formal education related fully with their geotechnical numerical analysis activity.
5. Many organisations have small teams of engineers engaged in part-time use of geotechnical numerical analysis tools. This suggests that many organisations have not accumulated a significant body of expertise in this field and with a lack of in-house expertise, many engineers will be in need of accessible, external training resources.

6. 73% responded that there is no system to look-up and record achievement in competences in their organisations and a large majority (85%) thought such a system would be useful.
7. The four highest ranking issues concerning the application of numerical analysis in geotechnical engineering were: “validation of analysis results”, “obtaining soil/rock parameters”, “lack of money/time for training” and “poor access to in-house experts or no mentoring system”, all of which can be addressed by the COGAN project deliverables.
8. The preferred media for a competency framework are a secure website and company intranet, while the preferred number of skill levels is 3.
9. Respondents also expressed their preferences for areas of geotechnical numerical analysis in most need of competency definition and to be covered by the COGAN e-learning modules. These results, together with the others, will be used to guide the development of the COGAN deliverables for the remainder of the project.
10. This survey is also unique in this field and its results will be made freely available for industry and academia alike for improving training and other aspects of geotechnical numerical analysis in response to these findings.

10. APPENDICES

Appendix 1: ONLINE SURVEY

Appendix 2: SURVEY RESPONSE FULL DATA

Appendix 3: RESULTS OVERALL

Appendix 4: COMPARISON OF RESULTS BY COUNTRY

APPENDIX 1 – ONLINE SURVEY

COGAN Industry Needs Survey

1. Start Page

The COGAN project aims to improve competency in geotechnical numerical analysis.

Please help ensure that the COGAN project meets the needs of the geotechnical engineering industry by spending about 15 minutes completing this survey. We will reward your efforts with free extracts of NAFEMS Geotechnical publications in PDF form.

Please be assured that all responses are strictly confidential.

Click Next to get started.

Page 1

COGAN Industry Needs Survey

2. Your details

If any of your responses in this survey don't fit into the options provided, or you would like to provide more information, please make a note of the question number and add a comment at the end of the survey.

1. Your location (European country or worldwide region).

2. Age

3. Position

- ◯ Technician/Designer
- ◯ Engineer/Analyst
- ◯ Senior Engineer
- ◯ Project Manager
- ◯ Director
- ◯ Academic
- ◯ Other (please specify)

4. Higher Education (EQF levels)

- ◯ Diploma/Bachelor's Degree (EQF level 6)
- ◯ Masters Degree (EQF level 7)
- ◯ PhD, Doctorate (EQF level 8)
- ◯ Other (please specify)

5. How long have you been involved in geotechnical numerical analysis and simulation?

- ◯ <1 year
- ◯ 1-2 years
- ◯ 2-5 years
- ◯ 5-10 years
- ◯ 10+ years

6. Over the past 6 months, what percentage of your working time has been spent involved in geotechnical numerical analysis and simulation?

COGAN Industry Needs Survey

7. How does your university education relate to your numerical analysis and simulation activity (where 0=not related and 3=fully related)?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3

COGAN Industry Needs Survey

3. Organisation details

For large, multinational organisations it may be difficult to provide answers for the whole organisation. Therefore, please provide answers for the domain you are familiar with (e.g. the country or office where you work).

8. Nature of organisation (tick all that apply)

- ☐ Design office/consultancy
- ☐ Contractor
- ☐ Research and development
- ☐ University
- ☐ Training provider
- ☐ Software developer/vendor
- ☐ Other (please specify)

9. Industry sector (tick all that apply)

- ☐ Civil and Construction
- ☐ Marine and Offshore
- ☐ Oil and Gas
- ☐ Mining
- ☐ Other (please specify)

10. Size of organisation

- ○ 1-20 employees
- ○ 21-50 employees
- ○ 51-100 employees
- ○ 101-250 employees
- ○ 250-500 employees
- ○ 500+ employees

11. Number of people using geotechnical numerical analysis and simulation tools.

COGAN Industry Needs Survey

12. The software you use for geotechnical numerical analysis and simulation is (tick all that apply)

- ☐ commercially available (with standard material models provided with software)
- ☐ commercially available (with user-defined material models)
- ☐ commercially available (with in-house modifications)
- ☐ developed in-house
- ☐ developed externally/tailored to your needs
- ☐ open source
- ☐ Other (please specify)

13. How much of your organisation's time is spent using these different geotechnical numerical methods? (The total must be 100).

Discrete Element Method (DEM) [%]

Finite Difference Method (FDM) [%]

Finite Element Method (FEM) [%]

Other numerical method [%]

14. In what field of geotechnical engineering is your organisation working? (percentage of working time, sum of both must be 100)

Soil Mechanics [%]

Rock Mechanics [%]

COGAN Industry Needs Survey

15. In your opinion, what are the main issues concerning the use of geotechnical numerical analysis software in industry? (where 0=not an issue and 3=serious issue)

	0	1	2	3
Difficult to understand	○	○	○	○
Poor access to in-house experts or no mentoring system	○	○	○	○
Lack of money / time for training	○	○	○	○
No convenient, cost effective and relevant external training	○	○	○	○
Software time consuming to use / pressure of work	○	○	○	○
Validation of analysis results	○	○	○	○
Inadequate material models	○	○	○	○
Expensive software	○	○	○	○
Obtaining soil/rock parameters	○	○	○	○
Simpler/cheaper analysis methods are adequate	○	○	○	○
A career as a numerical analysis specialist is unappealing/unrewarding	○	○	○	○

Other (please specify)

16. In your organisation, are the competences needed to perform different geotechnical numerical analysis tasks formally defined?

17. In your oganisation, is there a system for looking-up and recording staff competences in geotechnical analysis and simulation?

COGAN Industry Needs Survey

4. Existing system to record analyst competences at your organisation

18. What medium does your company use to record analyst competences? (tick all that apply)

- [ ] paper based
- [ ] company intranet
- [ ] external internet site
- [ ] commercially available software
- [ ] in-house developed software

Please state external internet site or software, if used

19. How many skill levels (e.g. standard, advanced) are in your existing system for recording analyst competences?

20. How are analyst competences assessed in your organisation? (Tick all that apply)

- [ ] Self-assessment
- [ ] Internal assessment by manager/mentor
- [ ] External assessment of submitted/project work
- [ ] Written/computer-based examination
- [ ] Interview/oral examination
- [ ] Other (please specify)

COGAN Industry Needs Survey

5. Ideal system to define and record analyst competences

21. Do you think a system that defines competences in geotechnical numerical analysis and provides links to appropriate training resources would be useful for professional development?

22. If you are aware of any systems for defining or recording analyst competences in geotechnical numerical analysis and simulation (except in your own organisation), please provide brief details here.

23. How useful do you think the following mediums are for recording analyst competences? (where 0=no use and 3=very useful)

	0	1	2	3
Paper based	○	○	○	○
Secure website	○	○	○	○
Company intranet	○	○	○	○
Standalone software	○	○	○	○

24. How many skill levels (e.g. standard, advanced, ...) would be the most appropriate?

COGAN Industry Needs Survey

6. Ideal system to define and record analyst competences

25. Which of the areas listed below should be included in a system to define competences in geotechnical numerical analysis? (Please rate the importance of each area where 0 = unimportant and 2 = very important).

	0	1	2
Fundamentals of Finite Element, FDM, DEM	○	○	○
CAD/CAE integration	○	○	○
Structural elements and interfaces (cables, beams, membranes, shells, embedded elements, interface elements, contact algorithms)	○	○	○
Constitutive models for geomaterials	○	○	○
Obtaining soil/rock parameters	○	○	○
Constitutive models and parameters for structural materials	○	○	○
Saturated/Unsaturated groundwater flow	○	○	○
Drained/Undrained analysis	○	○	○
Consolidation (coupled)	○	○	○
Creep in soft soils	○	○	○
Dynamics of vibrations and earthquakes (including site response, dynamic liquefaction)	○	○	○
Cyclic loading (large strains)	○	○	○
Coupled problems (thermo-hydro-mechanical)	○	○	○
Limit state analysis (including strength reduction for ULS)	○	○	○
Non-deterministic analysis	○	○	○
Optimization and sensitivity analysis	○	○	○
Pitfalls of numerical analysis for geotechnics	○	○	○
Validation of analysis results	○	○	○

If other, please specify

26. The competences to be defined covering the areas described above should be focussed in which of the following categories? (Please rate on a scale from 0-3 where 0=no focus and 3=highly focused)

	0	1	2	3
Background geotechnical knowledge	○	○	○	○
Generic analysis/simulation	○	○	○	○
Structure specific (tunnels, foundations, deep excavations, ...)	○	○	○	○
Software specific	○	○	○	○

COGAN Industry Needs Survey

7. Training needs

27. From your experience, rate the usefulness of the following learning methods in geotechnical numerical analysis: (where 0 = not useful and 3 = very useful)

	no experience	0	1	2	3
Attendance at face-to-face courses	○	○	○	○	○
Web-based formal learning	○	○	○	○	○
Web-based self-paced learning	○	○	○	○	○
Informal web-based self learning (e.g. Wikipedia, discussion forums, bulletin boards)	○	○	○	○	○
Private study	○	○	○	○	○
On-the-job learning/mentoring	○	○	○	○	○

If other, please specify

COGAN Industry Needs Survey

28. In which of the following fields would you like to see the COGAN project develop E-Learning modules next year (select two).

- [ ] Fundamentals of Finite Element, FDM, DEM
- [ ] CAD/CAE integration
- [ ] Structural elements and interfaces (cables, beams, membranes, shells, embedded elements, interface elements, contact algorithms)
- [ ] Constitutive models for geomaterials
- [ ] Obtaining soil/rock parameters
- [ ] Constitutive models and parameters for structural materials
- [ ] Saturated/Unsaturated groundwater flow
- [ ] Drained/Undrained analysis
- [ ] Consolidation (coupled)
- [ ] Creep in soft soils
- [ ] Dynamics of vibrations and earthquakes (including site response, dynamic liquefaction)
- [ ] Cyclic loading (large strains)
- [ ] Coupled problems (thermo-hydro-mechanical)
- [ ] Limit state analysis (including strength reduction for ULS)
- [ ] Non-deterministic analysis
- [ ] Optimization and sensitivity analysis
- [ ] Pitfalls of numerical analysis for geotechnics
- [ ] Validation of analysis results

If other, please specify

COGAN Industry Needs Survey

8. Further comments

29. Would you be willing to evaluate some deliverables of the COGAN project? This might involve a simple road-test of a product or a more technical review. If Yes, you must provide an email address in the last question.

- ◯ Yes
- ◯ No

30. Please provide any further comments or opinions you have on earlier questions or the COGAN project in general.

31. This is the end of the questionnaire. Thank you for your time and for completing this survey.

In order to receive free extracts of NAFEMS geotechnical publications and updates on the progress of the project, please enter your email address below (your email address will not be given to third parties). Then click Done to complete the questionnaire.

APPENDIX 2 – SURVEY RESPONSE FULL DATA

1. Your details

Q1. Your location

Answer Options	Response Percent	Response Count
Austria	4.4%	27
Belarus	0.2%	1
Belgium	0.6%	4
Bosnia & Herzegovina	0.2%	1
Bulgaria	0.3%	2
Croatia	0.5%	3
Cyprus	0.8%	5
Czech Republic	0.8%	5
Denmark	0.3%	2
Finland	0.3%	2
France	11.6%	72
Georgia	0.2%	1
Germany	10.5%	65
Greece	1.0%	6
Hungary	0.3%	2
Ireland	0.8%	5
Italy	5.0%	31
Monaco	0.2%	1
The Netherlands	1.0%	6
Norway	1.0%	6
Poland	1.0%	6
Portugal	1.6%	10
Romania	1.1%	7
Russia	1.1%	7
Slovenia	0.3%	2
Spain	10.2%	63
Sweden	10.8%	67
Switzerland	1.1%	7
Turkey	0.6%	4
Ukraine	0.3%	2
United Kingdom	7.8%	48
Africa	0.8%	5
Asia (Middle East)	1.1%	7
Asia	4.2%	26
Australasia	3.7%	23
North America	12.1%	75
South/Central America	2.1%	13

Q2. Age

Answer Options	Response Percent	Response Count
20-29	15.2%	94
30-39	37.8%	234
40-49	23.7%	147
50+	23.3%	144
	answered question	**619**
	skipped question	**0**

Q3. Position

Answer Options	Response Percent	Response Count
Technician/Designer	4.0%	25
Engineer/Analyst	29.2%	181
Senior Engineer	24.7%	153
Project Manager	6.9%	43
Director	8.4%	52
Academic	20.7%	128
Other (please specify)	6.0%	37
	answered question	**619**
	skipped question	**0**

Other (please specify):

- Manager, research branch
- Chief of department of seismic stability analysis
- PhD Candidate
- Designer and Consultant
- RESEARCH SCHOLAR
- Researcher
- Geoscientist
- Technical Writer
- Consultant, research
- review consultant (i.e. semi-retired !)
- Department head
- Manager Research
- responsible for numerical analyses
- Scientific assistant
- General Manager
- Business Professional
- Senior Geologist
- Civil engineering Intern
- Consultant in parttime

- PhD student
- Principal Engineer
- Software vendor
- Senior Geologist
- expediter
- postgraduate student
- Project Engineer
- Master Student, Currently working on Thesis
- Research Engineer
- Consultant
- Engineering Manager
- Geotechnical Engineer
- PhD candidate
- Geotechnical Adviser
- Associate Director
- Engineering geologist
- General Manager Validation (Simulation & Testing)
- Geotechnical Design Manager. Expert in FEM/FDM

Q4. Higher Education (EQF levels)

Answer Options	Response Percent	Response Count
Diploma/Bachelor's Degree (EQF level 6)	8.6%	53
Masters Degree (EQF level 7)	47.8%	296
PhD, Doctorate (EQF level 8)	40.4%	250
Other (please specify)	3.2%	20
	answered question	**619**
	skipped question	**0**

Other (please specify):

- Msc in Geotechnics
- university lecturer
- all possible scientific degrees(highest:DSc)
- Laurea VO (5 years degree)
- polytecnical college
- Licentiate of Technology
- Habilitation
- Senior Geologist
- Degree in geology
- PhD Candidate
- Maîtrise génie civil
- laurea
- DSc
- Dipl.-Ing. (TU)

- Ingénieur Ecole Nationale des Ponts et Chaussées, Paris
- Habilitation after PhD
- Diploma, German (Dipl.-Wirtsch.-Ing.) equivalent to M.Sc., NOT B.Sc.
- Dipl.-Ing. TU
- Diplom-Ingenieur (similar to Master Degree)
- MScCivEng + MScProgramming

Q5. How long have you been involved in geotechnical numerical analysis and simulation?

Answer Options	Response Percent	Response Count
<1 year	7.3%	45
1-2 years	8.7%	54
2-5 years	16.5%	102
5-10 years	25.0%	155
10+ years	42.5%	263
	answered question	**619**
	skipped question	**0**

Q6. Over the past 6 months, what percentage of your working time has been spent involved in geotechnical numerical analysis and simulation?

Answer Options	Response Percent	Response Count
<20%	40.9%	253
20-40%	26.7%	165
40-60%	13.7%	85
60-80%	10.8%	67
80-100%	7.9%	49
	answered question	**619**
	skipped question	**0**

Q7. How does your university education relate to your numerical analysis and simulation activity (where 0=not related and 3=fully related)?

Answer Options	Response Percent	Response Count
0	9.7%	60
1	34.7%	215
2	34.1%	211
3	21.5%	133
	answered question	**619**
	skipped question	**0**

2. Organisation details

Q8. Nature of organisation (tick all that apply)

Answer Options	Response Percent	Response Count
Design office/consultancy	60.7%	376
Contractor	13.4%	83
Research and development	18.3%	113
University	24.6%	152
Training provider	3.7%	23
Software developer/vendor	7.3%	45
Other (please specify)	5.2%	32
	answered question	**619**
	skipped question	**0**

Other (please specify):

- Mining Company
- Mining Company/University
- electricity generation
- Dept of Transportation - Design
- Consulting Geotechnical Engineer
- Operator
- production and trade of geosynthetic
- University and Consulting
- Province coorporation
- Corporation
- government/modifications
- government
- Environmental minister
- OEM
- mining company
- authority
- Special Foundations constrn & assoctd wrks
- goverment
- Public sector, roads and railways administarion
- Consultant International Company (www.geg.pt)
- road and railroad administration
- administration
- Client
- Ministry, departement of geotechnics
- public service in charge of control of hydraulic structure
- Manufacturer of construction products
- Client technical department
- Academy of Sciences
- Multidisciplinary Engineering Company

- National Governnent
- Government Regulator
- Government

Q9. Industry sector (tick all that apply)

Answer Options	Response Percent	Response Count
Civil and Construction	84.5%	523
Marine and Offshore	15.3%	95
Oil and Gas	15.0%	93
Mining	24.7%	153
Other (please specify)	6.5%	40
	answered question	**619**
	skipped question	**0**

Other (please specify):

- Geotechnical
- energy sector
- Hydropower
- Geotechnical Engineering
- Territory and natural resources manegament
- Nuclear
- University
- Geothermal
- Applied Geomechanics
- Nuclear waste storage
- Utility
- embankment dams
- environmental
- DAMS
- Engineering Geology
- Software development (geotechnical)
- Tunnelling
- multi-disciplinary
- Energy
- Rock mechanics
- energy-related subsurface technologies (e.g., geothermics, storage)
- General purpose software
- Forestry
- nuclear decommissioning
- hydropower
- All Industrial Sectors
- All of these, in particular geotechnics

- product of hydroelectricity
- geophysics
- Tunneling - Radiactive Waste Management
- Engineering Geology
- Geotechnics
- Design
- all of above
- Government
- dam design
- Nuclear
- General (All) FEA Simulation
- Railway, Automotive, Industrial Vehicle
- Academic

Q10. Size of organisation

Answer Options	Response Percent	Response Count
1-20 employees	23.6%	146
21-50 employees	12.8%	79
51-100 employees	12.0%	74
101-250 employees	10.2%	63
250-500 employees	8.2%	51
500+ employees	33.3%	206
	answered question	**619**
	skipped question	**0**

Q11. Number of people using geotechnical numerical analysis and simulation tools

Answer Options	Response Percent	Response Count
1	9.0%	56
2-5	35.9%	222
6-10	23.9%	148
11-50	22.6%	140
51-100	5.2%	32
100+	3.4%	21
	answered question	**619**
	skipped question	**0**

Q12. The software you use for geotechnical numerical analysis and simulation is (tick all that apply)

Answer Options	Response Percent	Response Count
commercially available (with standard material models provided with software)	82.2%	509
commercially available (with user-defined material models)	53.0%	328
commercially available (with in-house modifications)	19.1%	118
developed in-house	27.5%	170
developed externally/tailored to your needs	5.2%	32
open source	12.1%	75
Other (please specify)	1.0%	6
	answered question	**619**
	skipped question	**0**

Other (please specify):

- Specialized MathCad Calculations
- I only write about using the software
- wrote some routines myself piggy backed on open-source code
- DACSA
- all of the above, as we may use different software depending on the project needs
- Government

Q13. How much of your organisation's time is spent using these different geotechnical numerical methods? (The total must be 100)

Answer Options	Response Average	Response Total	Response Count
Finite Difference Method (FDM) [%]	24.18	10,202	422
Finite Element Method (FEM) [%]	63.86	36,527	572
Discrete Element Method (DEM) [%]	16.85	6,671	396
Other numerical method [%]	25.91	8,500	328
		answered question	**619**
		skipped question	**0**

Q14. What field of geotechnical engineering is your organisation working? (percentage of working time, sum of both must be 100)

Answer Options	Response Average	Response Total	Response Count
Soil Mechanics [%]	70.88	42,388	598
Rock Mechanics [%]	36.27	19,512	538
		answered question	**619**
		skipped question	**0**

Q15. In your opinion, what are the main issues concerning the use of geotechnical numerical analysis software in industry? (where 0=not an issue and 3=serious issue)

Answer Options	0	1	2	3	Rating Average	Response Count
Difficult to understand	74	249	223	73	1.48	619
Poor access to in-house experts or no mentoring system	59	165	242	153	1.79	619
Lack of money / time for training	57	170	241	151	1.79	619
No convenient, cost effective and relevant external training	86	233	223	77	1.47	619
Software time consuming to use / pressure of work	68	188	242	121	1.67	619
Validation of analysis results	39	155	225	200	1.95	619
Inadequate material models	105	271	149	94	1.37	619
Expensive software	69	184	213	153	1.73	619
Obtaining soil/rock parameters	54	136	221	208	1.94	619
Simpler/cheaper analysis methods are adequate	103	270	190	56	1.32	619
A career as a numerical analysis specialist is unappealing/unrewarding	163	226	149	81	1.24	619
Other (please specify)						28
					answered question	**619**
					skipped question	**0**

Other (please specify):

- Simpler/cheaper analysis methods are adequate in opinion of a contracting entity's 3
- Consultants who are not capable to do numerical modelling
- Users do not have a solid theoretical background. No criticism on results & methods.
- I think the main answer is that all of these are issues, so it requires a specialist and is difficult for an engineer to pick up when needed. Being a dedicated specialist in this area is probably unrewarded and isolated.

- Numerical analysis should be more emphasized in the industry. This also requires the people working with numerical analysis take the responsibility and deliver serious software products and analysis results.
- clients do not support the spend needed to do numerics thoroughly - the market does not see value.
- lack of will to do things differently
- retro analysis will remain an important apply of Nu An.
- too less exchange of knowledge between the users
- benefits not recognised fully by clients
- Lack of skilled people to use the software
- lack of published case studies comparing the analytical prediction with actual measurements.
- No Risk Analyses inclued on software
- lack of understanding of FEM, DEM, FDM in users
- lack of feedback from construction site measurements, little learning
- Questions not adapted to university
- comparing analysis results obtained par others methods or feedbacks
- lack of confidence
- Cumputer capaciti limitations for 3D
- weak theoretical backgroung / black box-analysis
- people often are using soil parameters for FEM bute they do not have enough experience with soil mechanics in the basics
- Smooth Particle Hydrodynamics not adapted to geothecnical problems
- Dont do geotechincal
- used by too many people not knowing what they are doing!
- Not a deep understanding of how the software works and correlation with the physical mechanisms and soil -foundation behavior
- Assumption that younger staff know how to use it because of better computer literacy
- Training on how to use a software package may be 1 week but training to understand the software and constitutive models likely involves university coursework and a lot more time.

Q16. In your organisation, are the competences needed to perform different geotechnical numerical analysis tasks formally defined?

Answer Options	Response Percent	Response Count
Yes	37.6%	233
No	62.4%	386
	answered question	**619**
	skipped question	**0**

3. Existing systems

Q17. In your organisation, is there a system for looking-up and recording staff competences in geotechnical analysis and simulation?

Answer Options	Response Percent	Response Count
Yes	27.1%	168
No	72.9%	451
	answered question	**619**
	skipped question	**0**

Q18. What medium does your company use to record analyst competences? (tick all that apply)

Answer Options	Response Percent	Response Count
paper based	52.9%	90
company intranet	51.8%	88
external internet site	8.8%	15
commercially available software	22.4%	38
in-house developed software	18.2%	31
Please state external internet site or software, if used		4
	answered question	**170**
	skipped question	**449**

Q19. How many skill levels (e.g. standard, advanced) are in your existing system for recording analyst competences?

Answer Options	Response Percent	Response Count
None	34.7%	59
1	5.9%	10
2	14.1%	24
3	27.1%	46
4	8.2%	14
5	7.1%	12
6+	2.9%	5
	answered question	**170**
	skipped question	**449**

Q20. How are analyst competences assessed in your organisation? (Tick all that apply)

Answer Options	Response Percent	Response Count
Self-assessment	65.3%	111
Internal assessment by manager/mentor	62.4%	106
External assessment of submitted/project work	24.1%	41
Written/computer-based examination	8.2%	14
Interview/oral examination	12.4%	21
Other (please specify)	2.4%	4
	answered question	**170**
	skipped question	**449**

Other (please specify):

- Self-assessment, but you can see what your colleague's competency level is to use as a gauge
- PhD Dissertation and Defense
- By dissertation, we are researchers (PhD)
- Record of training / experience

4. Ideal generic systems

Q21. Do you think a system that defines competences in geotechnical numerical analysis and provides links to appropriate training resources would be useful for professional development?

Answer Options	Response Percent	Response Count
Yes	84.5%	523
No	7.6%	47
Not applicable	7.9%	49
	answered question	**619**
	skipped question	**0**

Q22. If you are aware of any systems for defining or recording analyst competences in geotechnical numerical analysis and simulation (except in your own organisation), please provide brief details here

Answer Options	Response Count
answered question	**71**
skipped question	**548**

Comments

1. Test and calibration
2. I don't know any.
3. Most companies offering courses provide a certificate and many provide a time value for professional development hours as defined by some professional engineering organization.
4. Recently published Large Open Pit Mining book, by Stacey and Read
5. Not one that is competent enough. The only one is to go to Imperical College to do MSc in Soil Mechanics with Prof Potts and Prof Lidja.
6. no
7. Not applicable.
8. I am not aware of any.
9. No description
10. "Items:- Knowledge in Theory of Geomechanics- Knowledge in Laboratory and Field Testing- Tutorial database- Time to go through at least 80% of the tutorials"
11. I am not
12. The most recognized training is graduate level training in graduate level civil engineering programs.
13. NA
14. N/A
15. xxxxxxxxxxxxxxxxxxxxxxxx
16. Not very sure
17. no. difficult when using in house developed software
18. Unaware
19. not aware of anything
20. Not aware
21. sadly, those who claim to be 'competent' rarely are and despit ehaving a phd with numerical component. the understanding of mechanic in our industry is dire.
22. Excel
23. NA
24. geostudio/w
25. No! I read papers and theses and if someone has used that software I contact them hopefully they can give me advices. This is a great idea to make a list of software experts and a summary of what they have done with the software.Please pursue it.
26. /
27. "Analysis of Two-Dimensional Structures Using Slope Stability Programs". Port Engineering Technical Committee. Spanish Section of PIANC.
28. -
29. unaware
30. each young analyst should have a mentor, sometimes "pair working" like "pair programming in software development (Extrem Programming)
31. Mountain building and superposed folding

32. geotechnical skills are essential
33. LinkdIn (basic)
34. ...
35. ITASCA, Plaxis, Rocksience
36. depends on how many projects and what kind of projects
37. No
38. not aware
39. Not aware
40. ---
41. Very fast and in limited time in geotechnical numerical analysis and simulation.
42. Not known to me.
43. "FDMFEM"
44. No
45. Not aware
46. NAFEM
47. no remarks
48. Linkedin
49. None
50. none
51. no
52. professional group on linkedin
53. .Not aware
54. -
55. unfortunately, no
56. Not aware of such systems
57. Opensees platform
58. own non-algebraic spectral finite elements
59. The competency of numerical analyses must also include the competency of judging the
60. yes
61. --
62. no comment
63. Not specifically but something similar to register of geotechnical professionals (RoGEP) would be useful.
64. Unaware of any. NAFEMS publication only.
65. N/A
66. Not know
67. No, probably NAFEMS will have but you need to investigate.
68. NAFEMS PSE Certification
69. no
70. No
71. No

Q23. How useful do you think the following mediums are for recording analyst competences? (where 0=no use and 3=very useful)

Answer Options	0	1	2	3	Rating Average	Response Count
Paper based	136	216	166	101	1.37	619
Secure website	58	128	263	170	1.88	619
Company intranet	79	146	253	141	1.74	619
Standalone software	146	238	159	76	1.27	619
					answered question	**619**
					skipped question	**0**

Q24. How many skill levels (e.g. standard, advanced...) would be the most appropriate?

Answer Options	Response Percent	Response Count
1	1.6%	10
2	8.4%	52
3	54.4%	337
4	27.0%	167
5+	8.6%	53
answered question		**619**
skipped question		**0**

Q25. Which of the areas listed below should be included in a system to define competences in geotechnical numerical analysis? (Please rate the importance of each area where 0 = unimportant and 2 = very important)

Answer Options	0	1	2	Rating Average	Response Count
Fundamentals of Finite Element, FDM, DEM	16	141	462	1.72	619
CAD/CAE integration	133	315	171	1.06	619
Structural elements and interfaces (cables, beams, membranes, shells, embedded elements, interface elements, contact algorithms)	25	232	362	1.54	619
Constitutive models for geomaterials	13	151	455	1.71	619
Obtaining soil/rock parameters	13	146	460	1.72	619
Constitutive models and parameters for structural materials	40	324	255	1.35	619
Saturated/Unsaturated groundwater flow	32	298	289	1.42	619
Drained/Undrained analysis	18	183	418	1.65	619
Consolidation (coupled)	27	240	352	1.53	619
Creep in soft soils	69	318	232	1.26	619
Dynamics of vibrations and earthquakes (including site response, dynamic liquefaction)	60	305	254	1.31	619
Cyclic loading (large strains)	103	324	192	1.14	619
Coupled problems (thermo-hydro-mechanical)	177	311	131	0.93	619
Limit state analysis (including strength reduction for ULS)	42	259	318	1.45	619
Non-deterministic analysis	135	374	110	0.96	619
Optimization and sensitivity analysis	59	276	284	1.36	619
Pitfalls of numerical analysis for geotechnics	38	241	340	1.49	619
Validation of analysis results	8	119	492	1.78	619
If other, please specify					18
				answered question	**619**
				skipped question	**0**

If other, please specify:

- Hey guys ... numerical modeling is ONLY ONE tool that geotech engineers need .... and not a very important one
- Not sure why the obsession with validation. To do validation means a known solution is available. This is only available for elastic models!
- we don't need a system to define/track competences; we just need to develop them
- Probabilistic analysis
- why would you NOT include any of these in such a system? the question seems silly without context
- It is all important. I think the variety of modelling skills and capabilities may be too wide for this approach. To me modelling requires and integrated understanding of the engineering and the

numerics. I think a system of specific competencies may lead to people with things on the wall that could imply capability beyond true ability.
- programming, mesh quality control, Rock/Soil mechanics knowledge, State of the Art
- Coupling codes like reservoir simulater with FLAC or FLAC with PFC etc
- quality management - internal review - minimuim standards
- Fundamentals of mechanics, experience in mining industry
- non
- pimary stress field, boundary conditions, discontinuities, use for design (partial safety factors), ...
- I think I do not agree with your definition of valdiation so irt is difficult to answer the question
- Tunnelling and mining
- time dependent behaviour
- Smooth Parcticle Hydrodynamics adapted to geotechnical problems (soil slope slidings: interaction with wire mesh, cable nets, anchors)
- Time dependency /creep in rock e.g. Salt,
- In my experience most issues arise by mis-interpretation of correct modelling of undrained behaviour

Q26. The competences to be defined covering the areas described above should be focussed in which of the following categories? (Please rate on a scale from 0-3 where 0=no focus and 3=highly focused)

Answer Options	**0**	**1**	**2**	**3**	**Rating Average**	**Response Count**
Background geotechnical knowledge	7	42	192	378	2.52	619
Generic analysis/simulation	10	117	319	173	2.06	619
Structure specific (tunnels, foundations, deep excavations, ...)	12	88	293	226	2.18	619
Software specific	50	219	249	101	1.65	619
					answered question	**619**
					skipped question	**0**

Q27. From your experience, rate the usefulness of the following learning methods in geotechnical numerical analysis: (where 0 = not useful and 3 = very useful)

Answer Options	no experience	0	1	2	3	Rating Average	Response Count
Attendance at face-to-face courses	41	9	62	200	307	3.17	619
Web-based formal learning	150	40	193	183	53	1.92	619
Web-based self-paced learning	135	35	180	193	76	2.06	619
Informal web-based self learning (e.g. Wikipedia, discussion forums, bulletin boards)	71	98	269	145	36	1.96	619
Private study	21	39	139	261	159	2.80	619
On-the-job learning/mentoring	18	5	50	185	361	3.40	619
If other, please specify							9
						answered question	**619**
						skipped question	**0**

If other, please specify:

- private study with an easy access to the detailed solutions of more advanced examples with corresponding full data sets for various FEM packages 3
- Your survey should mention graduate level training at an acredited university.
- Software manuals
- non
- joint venture colleagues
- honest user meetings, not just 'success stories'
- development of codes for new applications
- workshops
- From papers

Q28. In which of the following fields would you like to see the COGAN project develop E-Learning modules next year (select two).

Answer Options	Response Percent	Response Count
Fundamentals of Finite Element, FDM, DEM	49.1%	304
CAD/CAE integration	16.6%	103
Structural elements and interfaces (cables, beams, membranes, shells, embedded elements, interface elements, contact algorithms)	32.1%	199
Constitutive models for geomaterials	46.5%	288
Obtaining soil/rock parameters	48.9%	303
Constitutive models and parameters for structural materials	20.2%	125
Saturated/Unsaturated groundwater flow	23.7%	147
Drained/Undrained analysis	32.1%	199
Consolidation (coupled)	23.3%	144
Creep in soft soils	17.1%	106
Dynamics of vibrations and earthquakes (including site response, dynamic liquefaction)	26.8%	166
Cyclic loading (large strains)	16.2%	100
Coupled problems (thermo-hydro-mechanical)	13.6%	84
Limit state analysis (including strength reduction for ULS)	24.6%	152
Non-deterministic analysis	10.2%	63
Optimization and sensitivity analysis	21.8%	135
Pitfalls of numerical analysis for geotechnics	27.1%	168
Validation of analysis results	39.3%	243
If other, please specify		8
	answered question	**619**
	skipped question	**0**

If other, please specify:

- The most important aspect must be validation of models. The most significant problem is in the use of invalid numerical models.
- superposed folding
- non
- proper documentation of analysis incl. quality assurance
- I am not waiting something from Cogan, but it is impossible in your questionnaire to answer "nothing"
- sheet pile modelling and design
- Salt Creep
- I do not care

Q29. Would you be willing to evaluate some deliverables of the COGAN project? This might involve a simple road-test of a product or a more technical review. If Yes, you must provide an email address in the last question.

Answer Options	Response Percent	Response Count
Yes	56.7%	351
No	43.3%	268
	answered question	**619**
	skipped question	**0**

Q30. Please provide any further comments or opinions you have on earlier questions or the COGAN project in general.

Answer Options	Response Count
answered question	80
skipped question	539

Comments or Opinions:

1. No further comments
2. I guess one of the most critical aspects is the awareness of the analysts about the limitations of their knowledge and the limitations of the results of the analyses they perform.
3. I would you like to see in next year the following E-Learning module: obtaining soil parameters for more advanced constitutive models
4. See this FYI http://www.wiete.com.au/journals/WTE&TE/Pages/Vol.7,%20No.2%20(2009)/6-14-Vairaktaris.pdf
5. There is an obsession with getting people competent for numerical modelling but the courses at universities are far from adequate and the field is too wide. Sometimes, one focussed on mathematics, some focussed on the numerical part of it and no input from real engineering. There are far too much obsession with validation which is only possible if you have a known results. It does not mean that it can be validated against a real problem. The people working on this are far too academic. Many modellers are incompetent but allowed to continue to model. There is also obsession with more complex 3D modelling that one cannot tell what is actually happening. There is no real direction and control from any organisation.
6. This is a very good initiative. there are many people who lack the competency to properly analyze geotechnical problems especially with numerical analysis
7. We are concerned about proper selection of method for a particular problem. Have seen instances where software selection decisions channeled analysis results away from important failure mechanisms.
8. I am very excited for this effort that you have put together. During all my education/training/life as a Geotech Engineer, the problems you are trying to tackle have been my one and only topic and concern.
9. None.
10. Excellent initiative
11. It would be great if COGAN facilitates the acces to learn numerical model technics by offering short courses and funding to anyone interested on the topics the project deals with
12. Industry is profit driven and profit is defined in short terms. The larger the company, the more formal and complicated... Hence buying new tools or introducing new methods is allways difficult because there is no quick and fast track decision process anymore. Either the expert goes the formal way or follows a guerillia strategy - this is the way we do. Undermining the defined processes for improving our tools and our skills.
13. I became interested in the Crandall Coal Mine disaster, and the validation of numerical models. I have made several presenations to the ASCE Geo Institute, and other organizations.
14. 1) I am from Costa Rica. I have a french engineering degree and I'm aware europeans don't care about central america, but we are doing really interesting things in numerical modelling of real geotechnical problems related to our hydroelectrical projects. Maybe you can consider to include a more detailed list of countries for the first question.

15. I wish you the best with this. I think you will have more luck in soil mechanics where the science/engineering is more well established. Rock mechanics is rapidly developing with modelling as an integral part. I think it will be a challenge to apply meaningful competencies. But if you couple the training with experience levels, maybe you will have something helpful.
16. NA
17. N/A
18. xxxxxxxxxxxxxxxxxxxxxxxxxx
19. "Overall, I think COGAN project seems an interesting idea. In my opinion, the main objective should be to facilitate access to training and learning, along with the exchange of information and experiences between professionals."
20. Cogan it's a good opportunities to improve our numerical analysis skills
21. It is really helpful in evaluating geotechnical softwares through this survey.
22. This appears to be an exceptionally worthwhile initiative.
23. Most clients require 3D packages these days. On the other hand building 3D models is a pain in most software like FLAC or 3DEC etc. There has been move to ease this but they are costly. Also the import function should work from typical mining packages such as Surpac, Datamine or Vulcan.
24. "The project sounds very useful. Great work team! I look forward to seeing the fruits of this work. I use Articulate e-learning authoring software and would recommend it for your consideration for the development of the e-learning modules. With regards to the survey questions, a ""N/A"" option would have been helpful."
25. very important to have a culture of validation and competence with the fundamentals of the mechanics of rock behaviour
26. None
27. Good and detailed survey
28. I hope to see in near future a geotechnical software for modelling water-conducting fractures in longwall mining.
29. looking forward to it
30. Access to an organization with mentoring consultants would be a big help for firms with small modeling groups.
31. no
32. This sounds like a good program that is long overdue
33. Excellent initiative; long overdue
34. The knowledge is important today, but I think that knowledge and experience in the job's world are better than only knowledge or educational. Studying and looking the reality are the just key to improve our job, I think
35. No
36. "Understanding the power of the correct use of FEM is a valuable tool for geotechnical simulation engineers - analysts but in order to do so proper training and education should be provided to those using FE softwares. COGAN will definitely improve competency and skills through the e-learning modules and by creating the need for the followers to learn and improve their skills and knowledge."
37. Is a good idea.
38. the COGAN project is a good idea useful for the young geotechnical Analyst and not only
39. ...
40. I believe that the geotechnical analysis needs experience. From my point of view, because of the turn-over in design teams, too few experts can advise engineers using FEA in the right way (inputs and outputs). Therefore COGAN may be of great interest for the profession.
41. scientists must work more and more together in order to have the best software for solving geotechnical problems
42. Very interesting

43. Geotech is the name of 'learning all the time'. Its excellent idea from COGAN to get in touch geotech professionals & deliver an improved system.
44. Great IDEA.! This project.
45. Give some information freely!
46. It is okey
47. It is more interesting, i need more information
48. "Having taught the FEM & Constitutive modelling courses to geotechnical engineering students for over 20 years, i can appreciate the difficulties faced by students and fresh engineers in applying finite element analysis techniques to geotechnical problems. The outcome of this project will certainly help the profession.
49. Very comprehensive survey form. Good job!
50. A very worthwhile project!
51. When software have an easy use, I observe that mistake is easy too !
52. What would be the proof of competency - e.g. peer review of analyses? Certificates? How else to be communicated as skill?
53. a french version of some texts will be welcome
54. Good Luck! Some of industry standards are inappropriate to the use of numerical methods such as finite elements, and imply the use of simple "standard" method.
55. "Your question are too self-oriented YOU are much more thinking at improving your organisation. Think more about the users independently of what you are doing: what the users do not know. At first are you sure the users understand your questions? This questionnaire seems to have been done by software sellers, not customers. I do not agree for example what you call validation. It is not possible in your questionnaire to answer: not adapted or I do not understand the question."
56. aschalew.abebe@grontmij.se
57. I would like to know more about this project
58. Very useful initiative! Willing and hoping to contribute in any way.
59. Wondering who you are and where you are based
60. good
61. Good initiative!
62. No furhter opinions.
63. congratulations for the initiative. I think it is a very good idea!
64. constructing robust shell-like solid non-algebraic finite elements
65. Congratulations for the project. I think it is going to lead to a real development in geotechnical engineering.
66. My only experience in geothecnical problems is using ANSYS-Autodyn because it includes Smooth Particle Hydrodynamics. I used it for my PhD thesis. I think this is a very powerful numerical approach to simulate movement of soils (large movements, high distorion) and interaction with other structures (cable nates, wire meses, anchors), with a low computational time. Specific geotechnical software (GEO-Slope, Plaxis, Flac) do not have this numerical formulation. By other hand, ANSYS-Autodyn is not prepared for geothecnical problems: e.g. do not deal with effective stresses.
67. "Hi, I am working on a research project about FEM Analysis of 3D urban environments. I am particularly interested in wind field simulations, heat flows, and blast simulations. Perhaps this might be an additional use case for your project"
68. Numerical Analyses must be part of geotechnical design and must not be separated from the complete design process.
69. "Question 6, the geotechnical department has been dedicating 60-80% to numerical analysis simulation. Question 13 is related to the geotechnical department, not the organization"
70. N/a
71. Looking forward to contribute to this project.

72. "Who has proposed the COGAN project? Which are the partners?"
73. hard task
74. Difficult qsurvey uestions I have some doubts about people will be able to understand every question meaning

Q31. This is the end of the questionnaire. Thank you for your time and for completing this survey. In order to receive free extracts of NAFEMS geotechnical publications and updates on the progress of the project, please enter your email address below (your email address will not be given to third parties). Then click Done to complete the questionnaire.

Answer Options	Response Count
answered question	**505**
skipped question	**114**

APPENDIX 3 – RESULTS OVERALL

Q1. Location of respondents

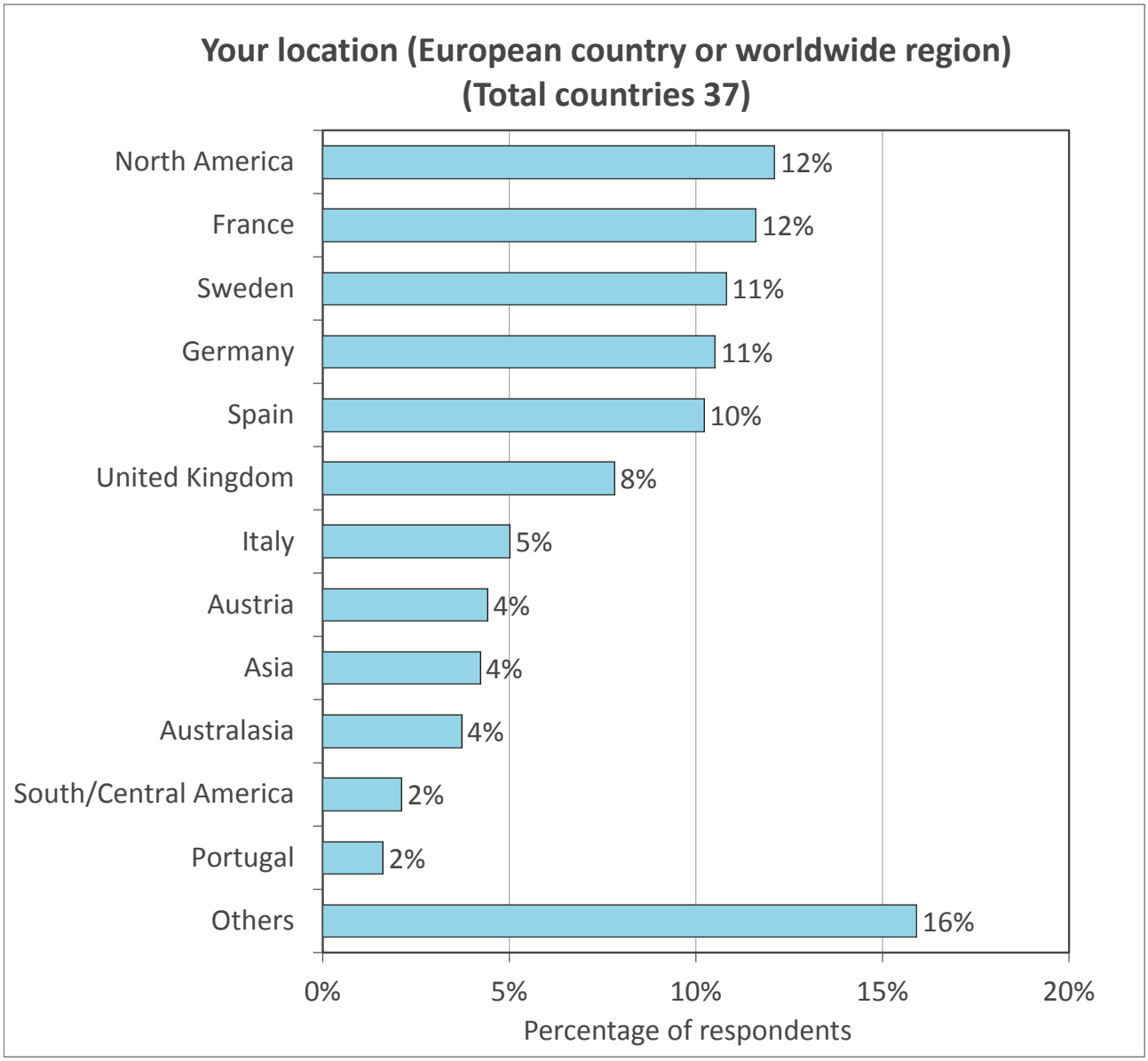

Figure A4. 1 – Location of respondents

Figure A4. 2 Number of respondents

Q2. Age of respondents

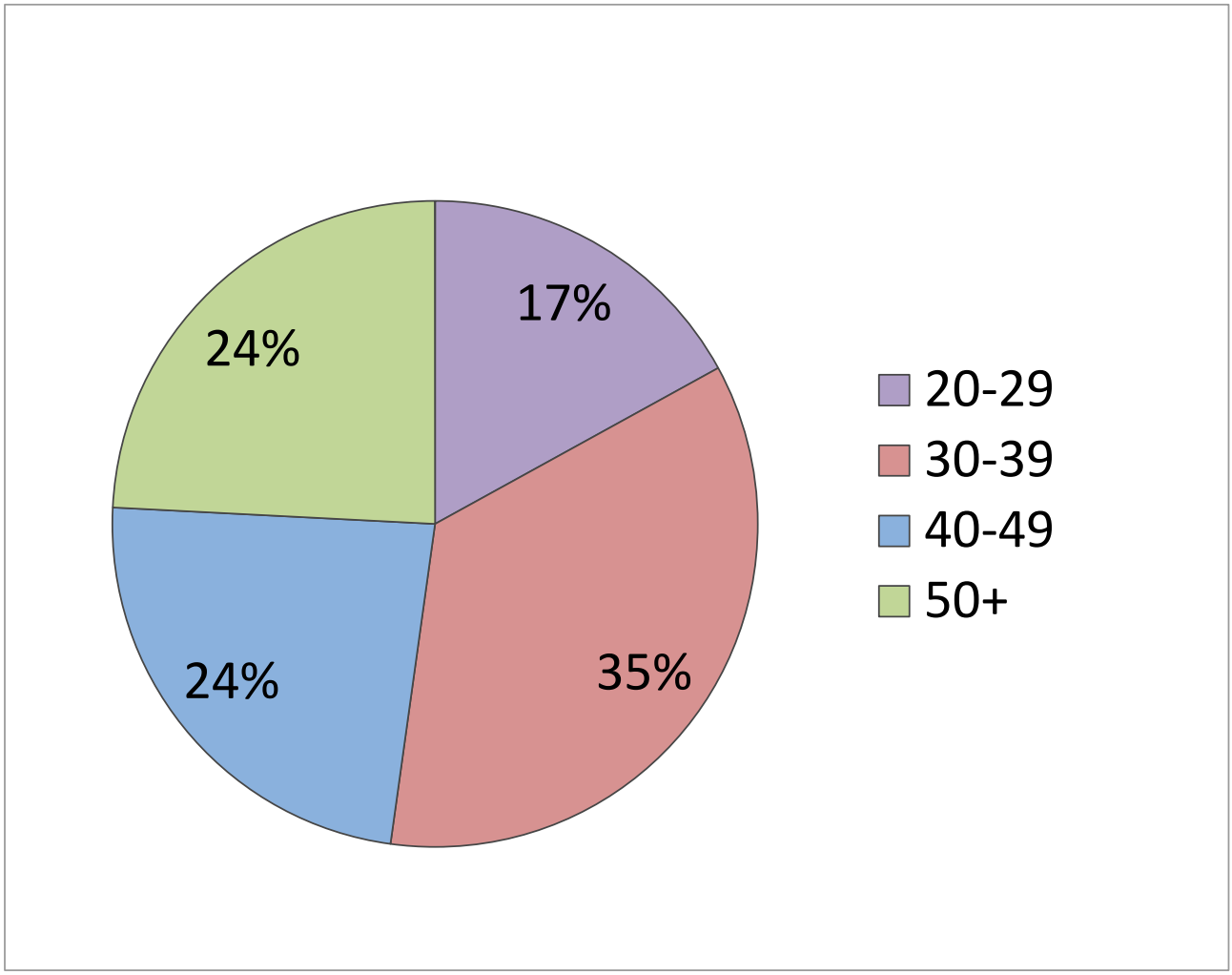

Figure A4. 3 – Age of respondents

Q3.Position of respondents

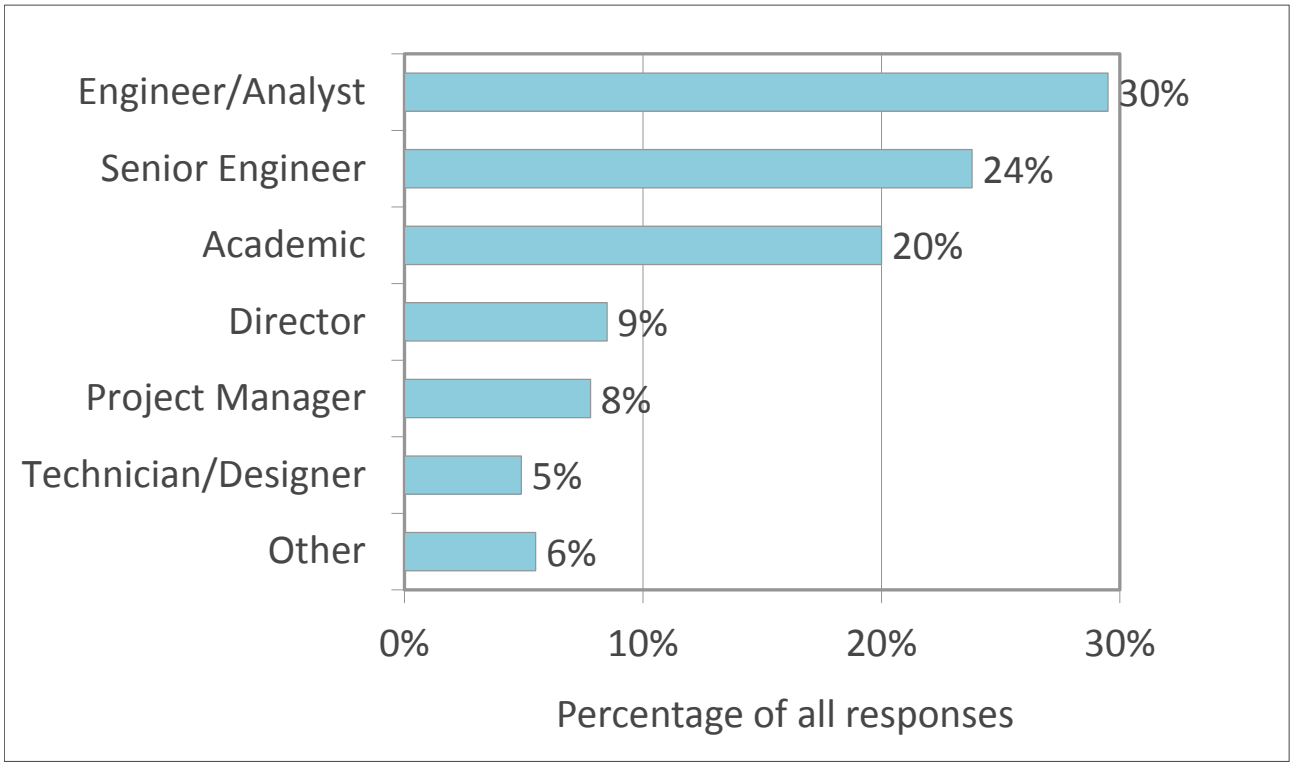

Figure A4. 4 – Position of respondents

Q4.Higher education (EQF levels)

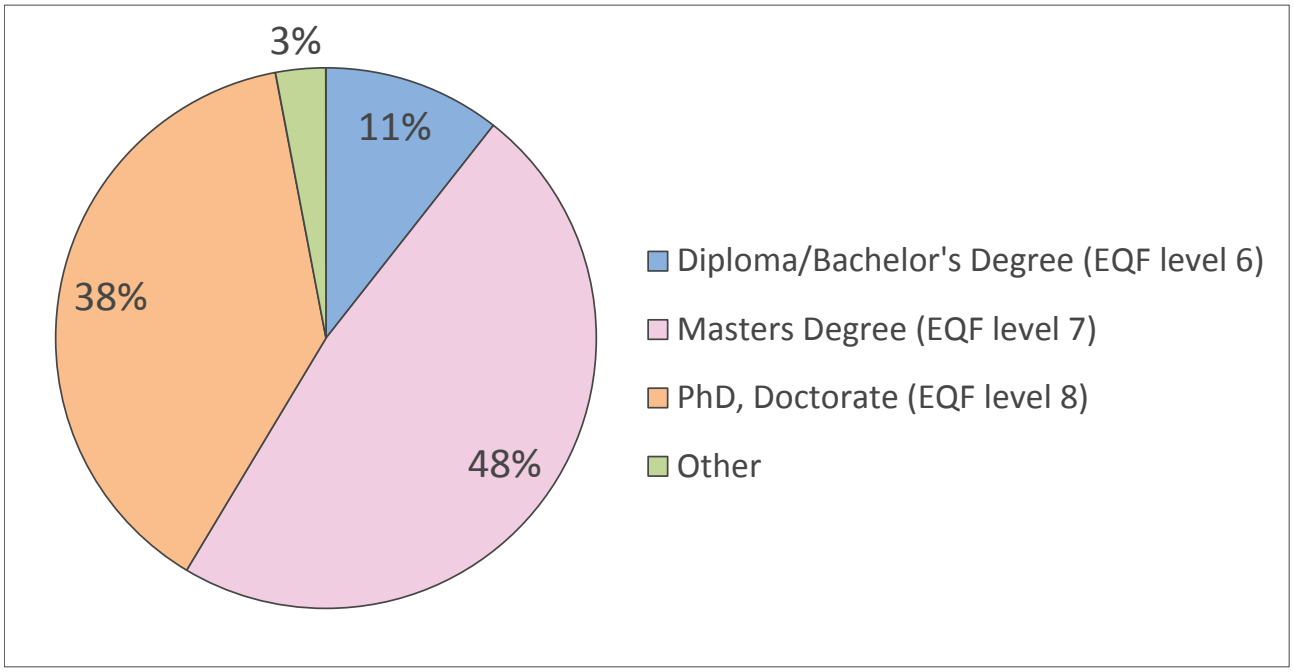

Figure A4. 5 – Education levels of respondents

Q5. How long have you been involved in geotechnical numerical analysis and simulation?

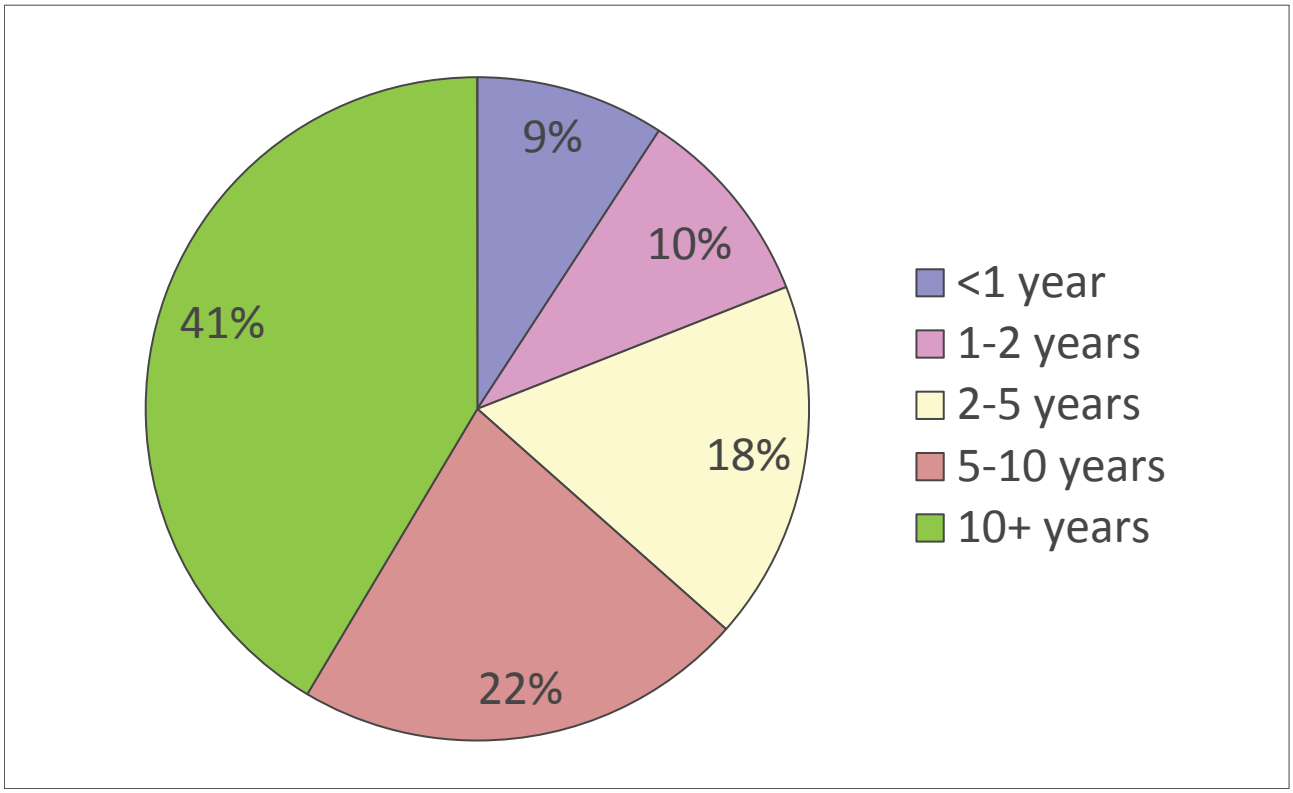

Figure A4. 6 – Time dedicated to geotechnical numerical analysis

Q6. Over the past 6 months, what percentage of your working time has been spent involved in geotechnical numerical analysis and simulation?

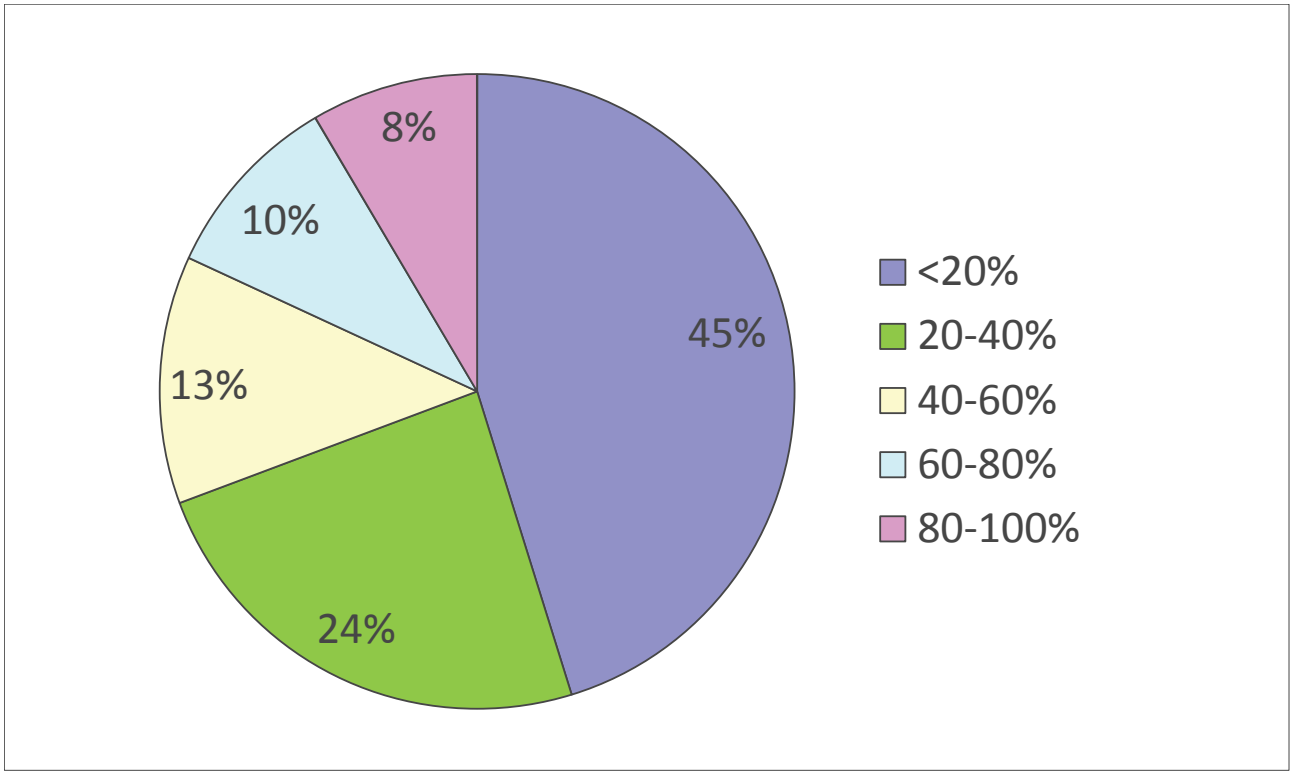

Figure A4. 7 – Working time spent in geotechnical numerical analysis

Q7. How does your university education relate to your numerical analysis and simulation activity (where 0=not related and 3=fully related)?

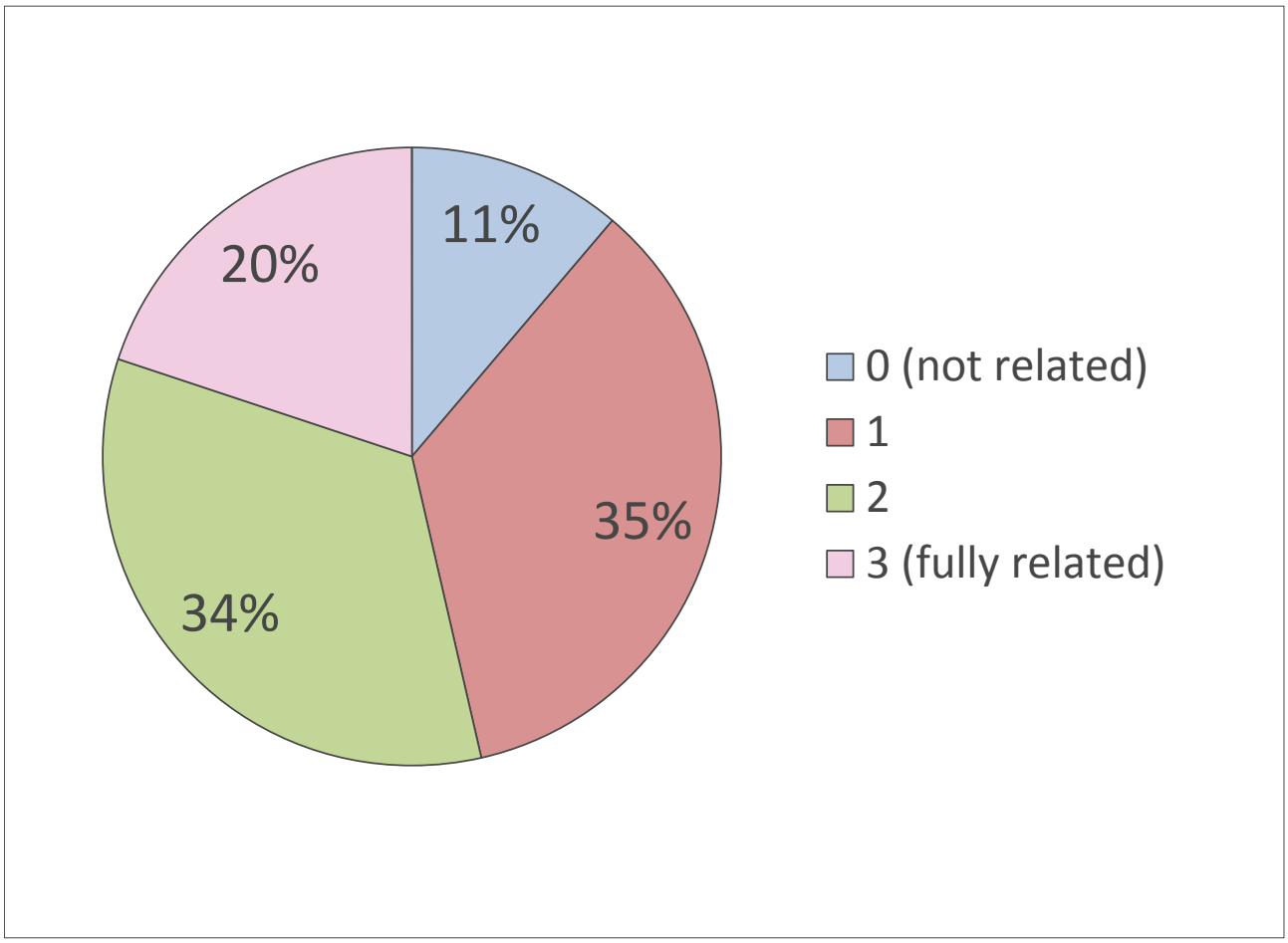

Figure A4. 8 – Relationship between university education and numerical analysis

Q8. Nature of organisation

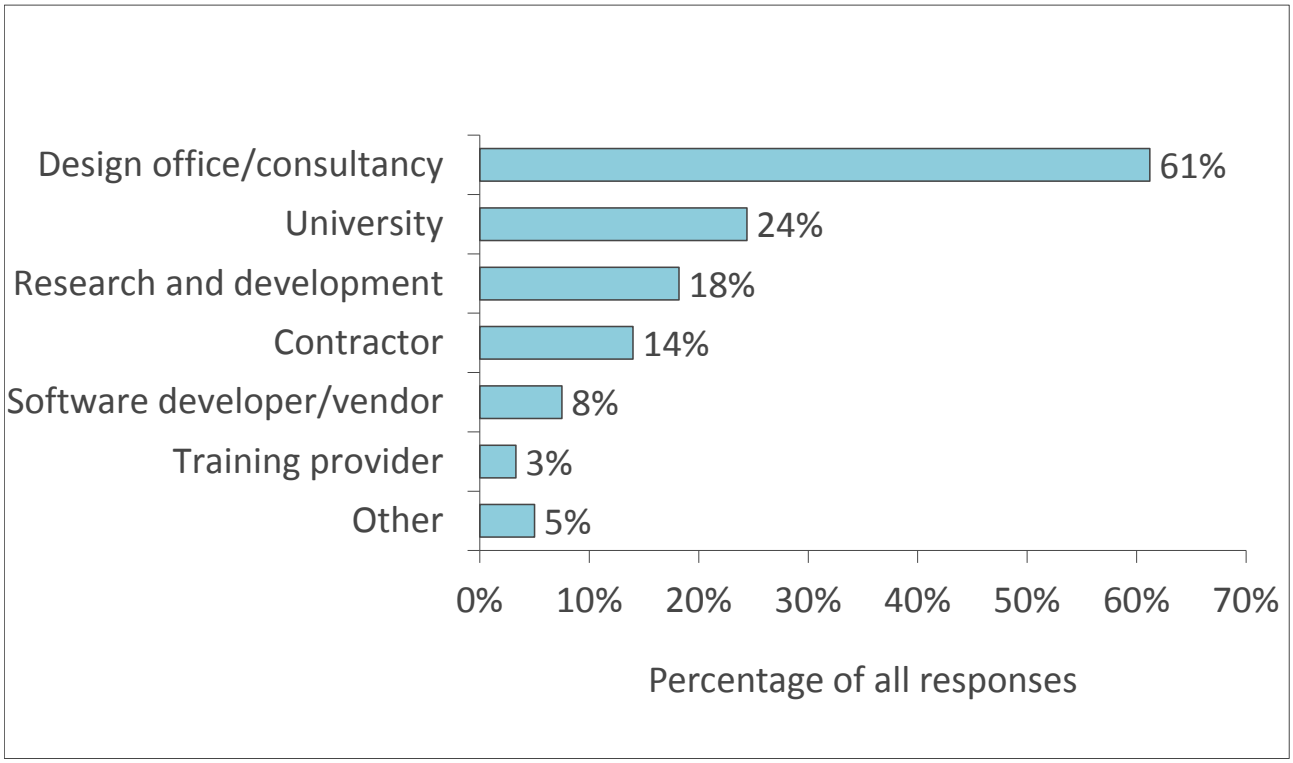

Figure A4. 9 – Nature of organisation

Q9. Industry sector

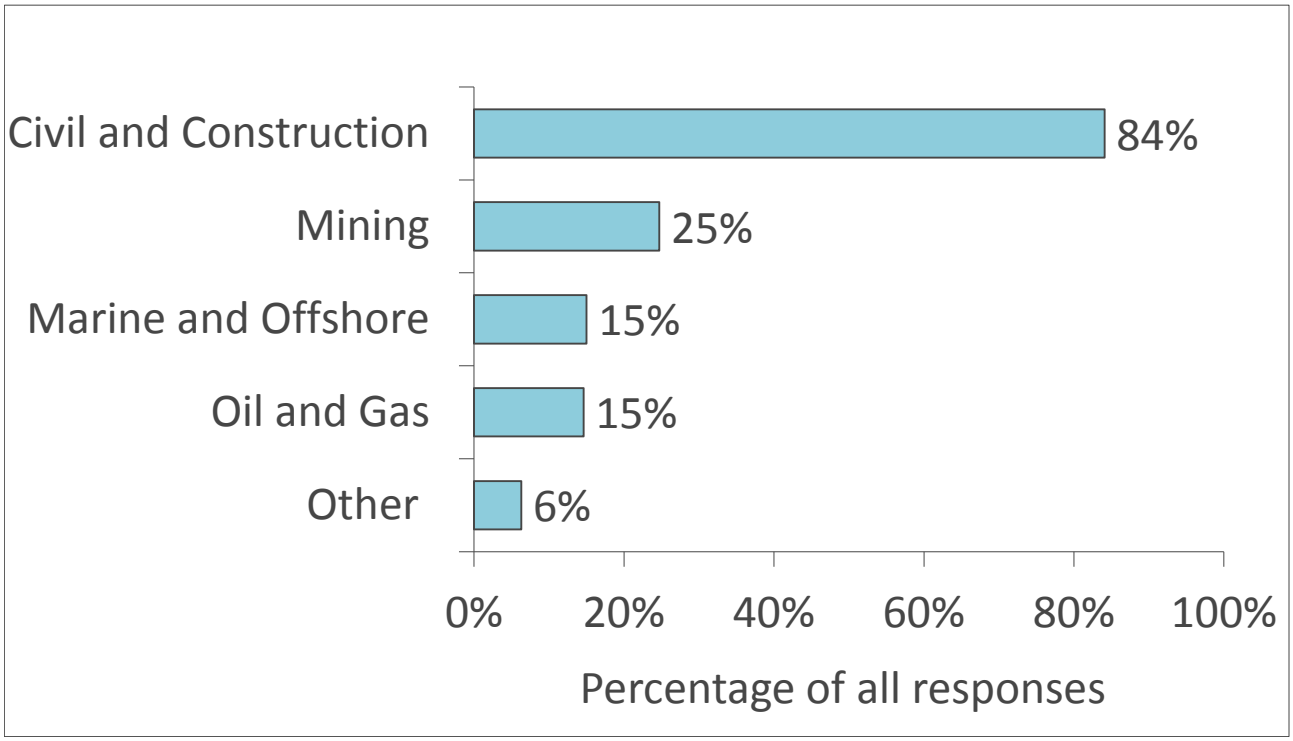

Figure A4. 10 – Industry sector

Q10. Size of organization

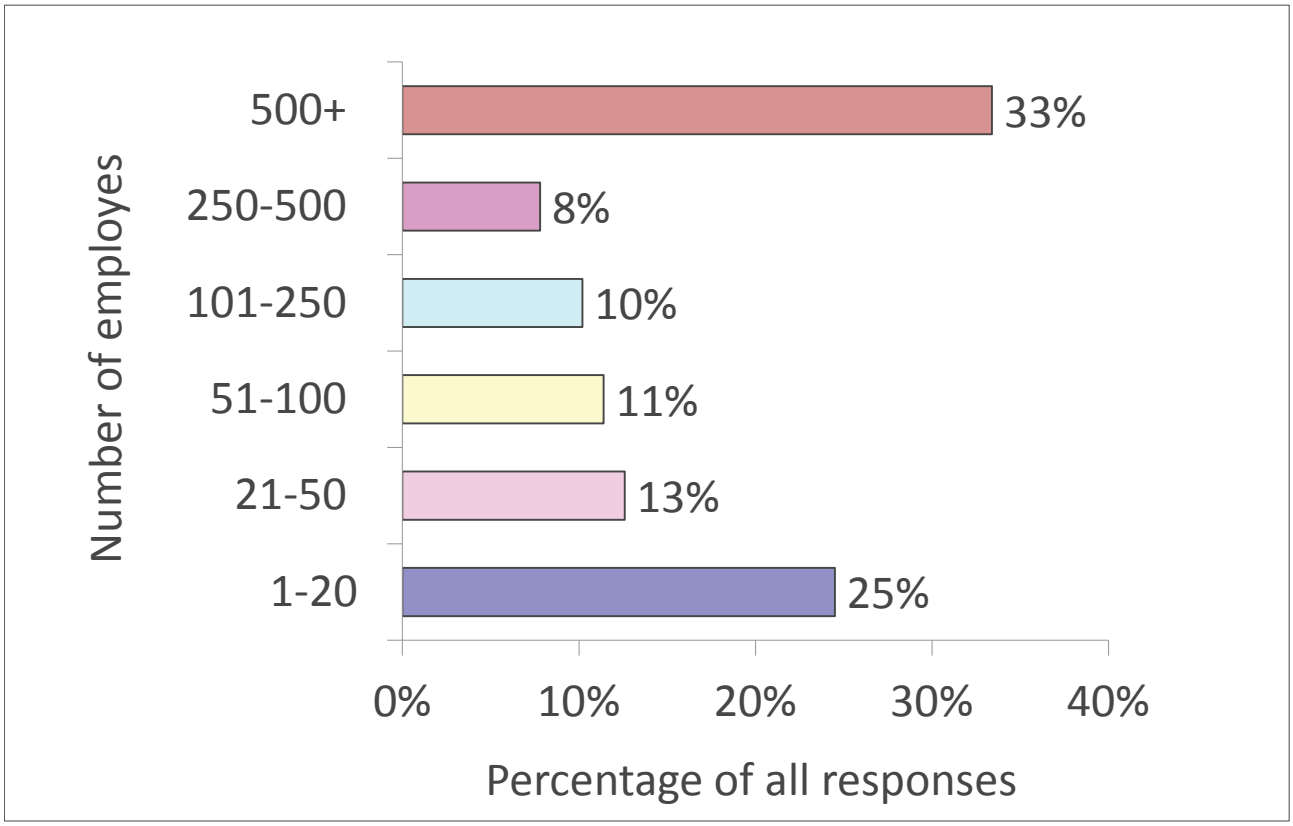

Figure A4. 11 – Size of organization

Q11. Number of people using geotechnical numerical analysis and simulation tools in your organisation

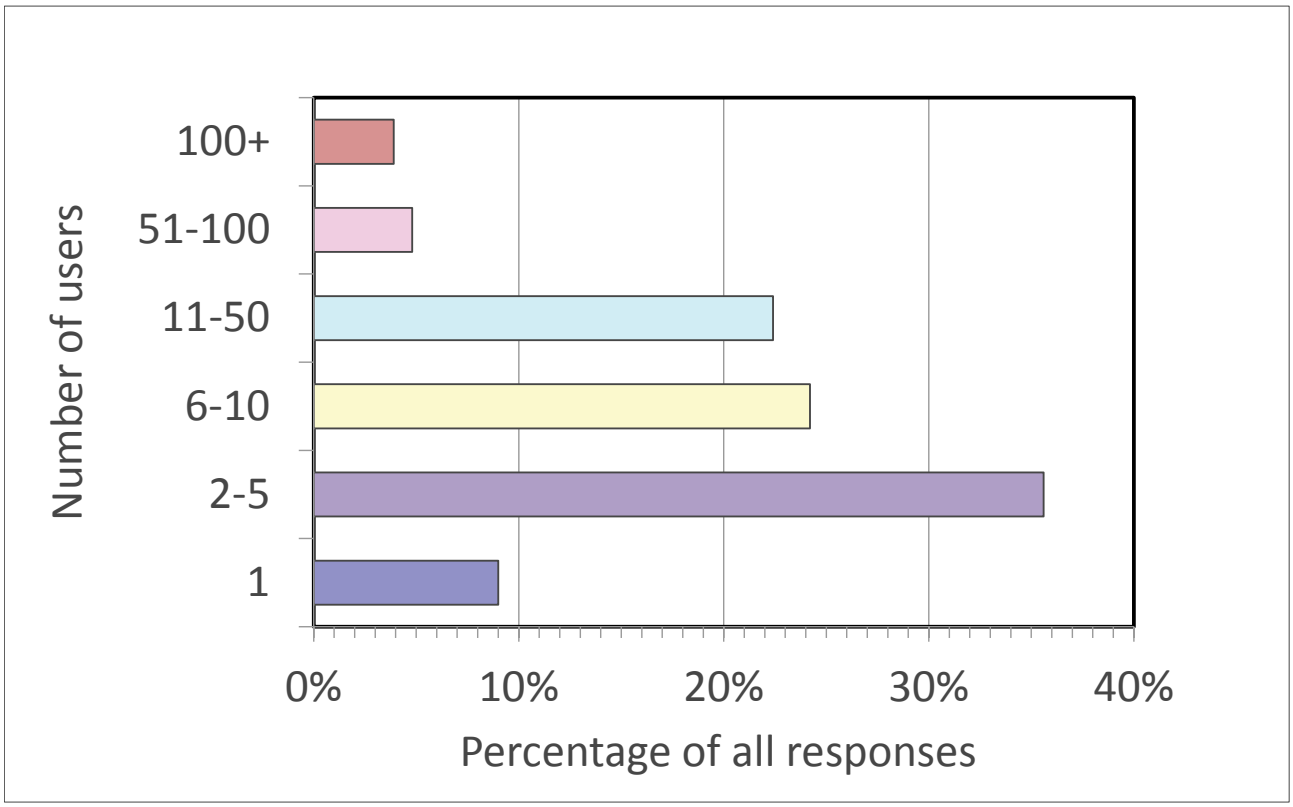

Figure A4. 12- Number of numerical analysis users

Q12. The software you use for geotechnical numerical analysis and simulation is :

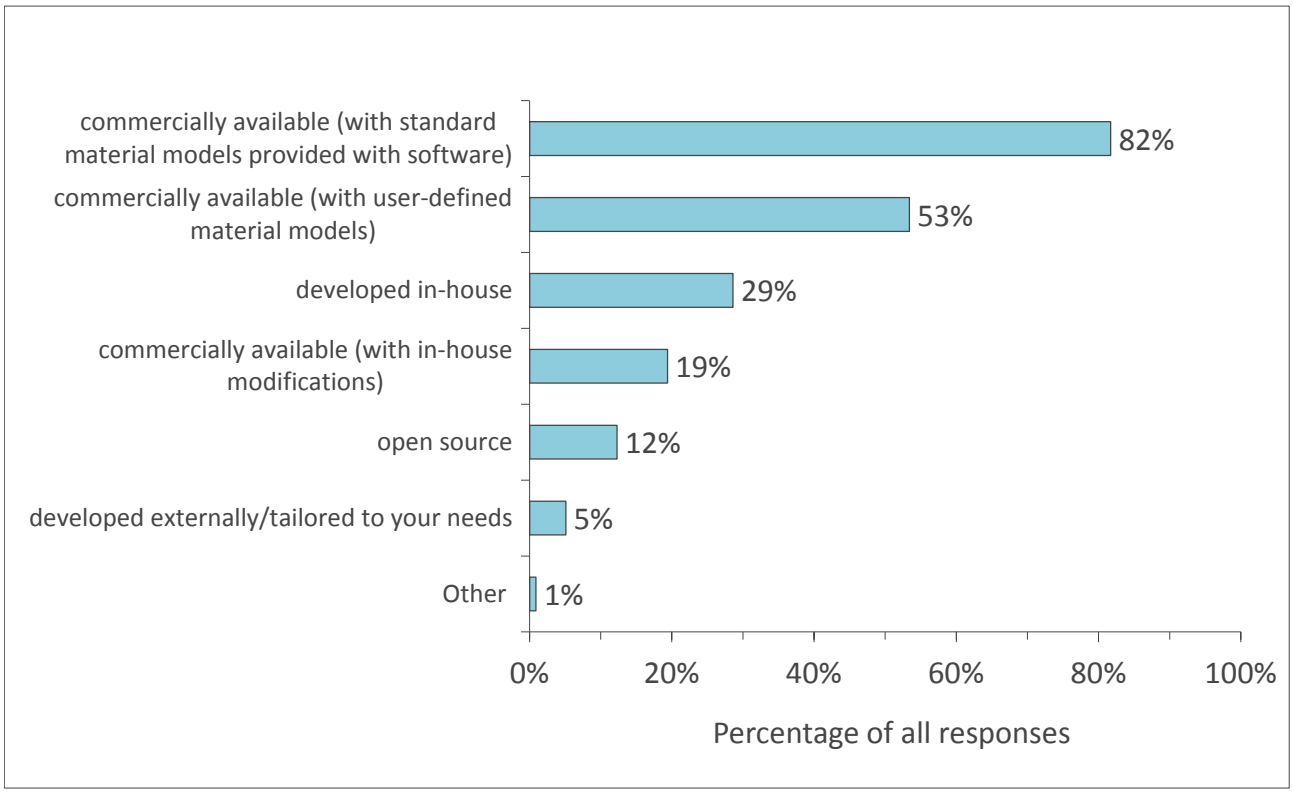

Figure A4. 13- Type of software used for simulations

Q13. How much of your organisation's time is spent using these different geotechnical numerical methods?

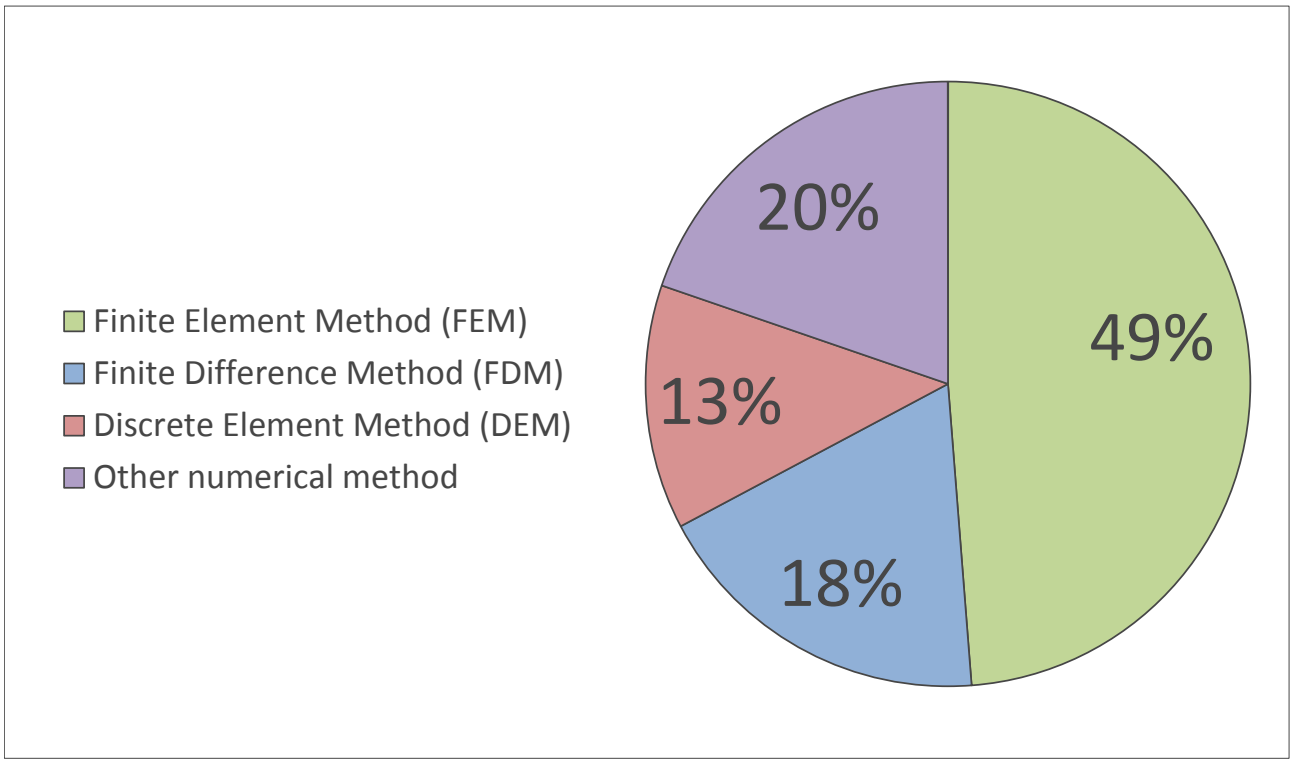

Figure A4. 14- Numerical methods used

Q14. In what field of geotechnical engineering is your organisation working?

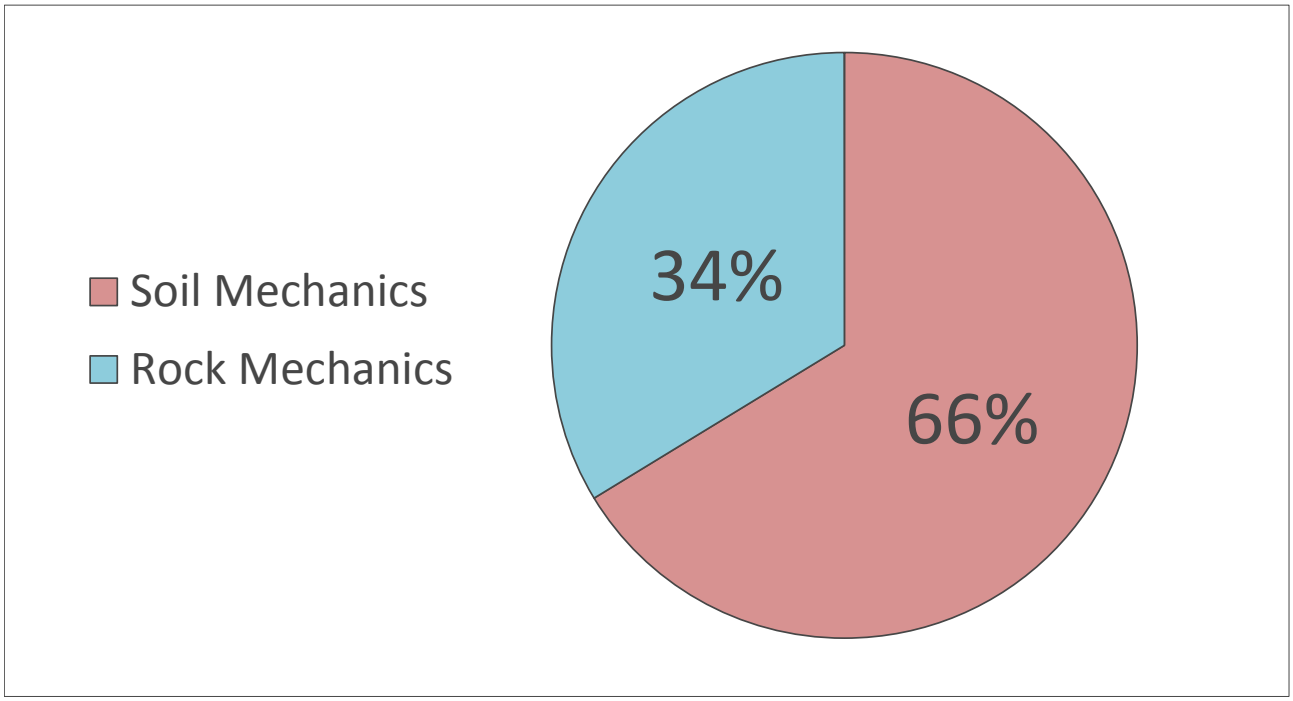

Figure A4. 15- Field of application of numerical methods

Q15. In your opinion, what are the main issues concerning the use of geotechnical numerical analysis software in industry? (where 0=not an issue and 3=serious issue)

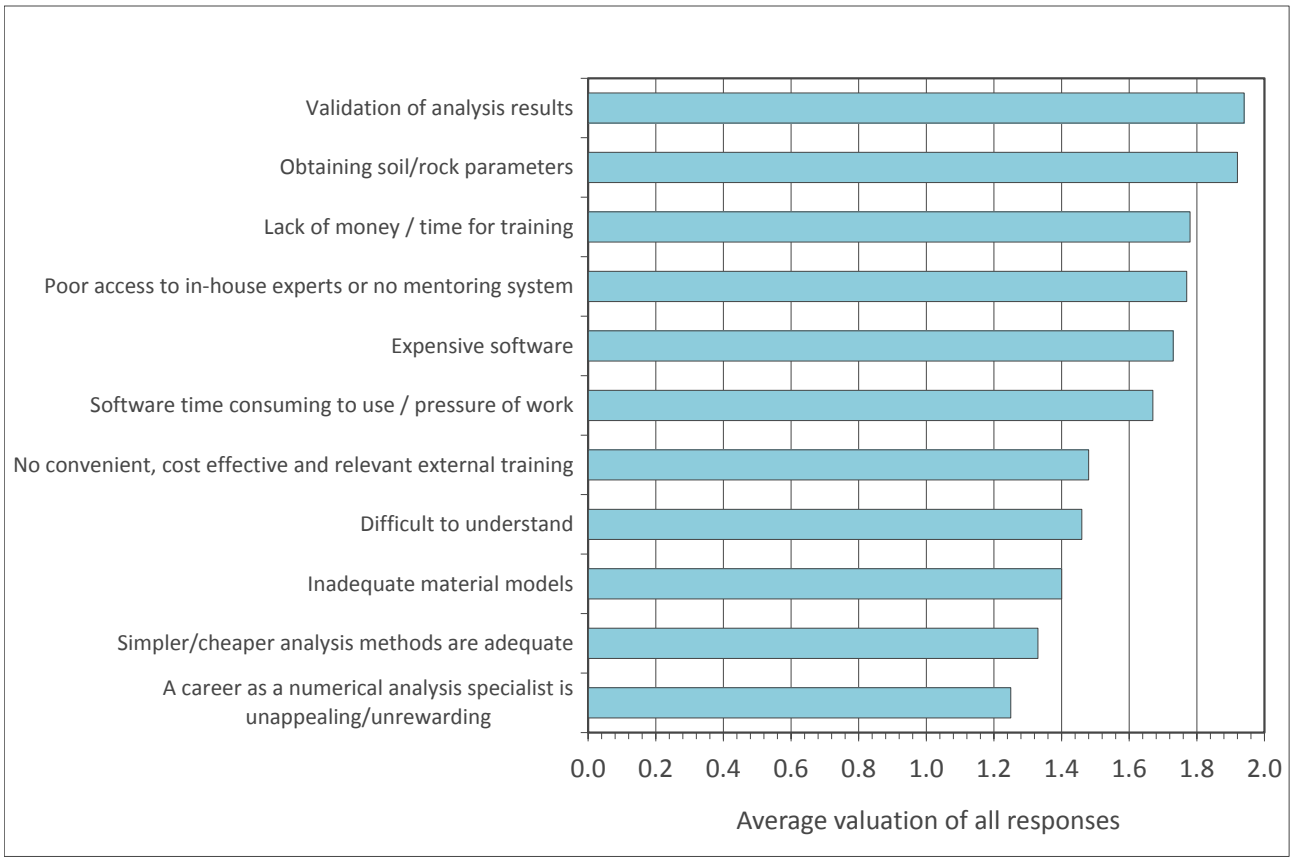

Figure A4. 16 - Problems related to the use of geotechnical numerical software

The following pictures present the valuation of each concern:

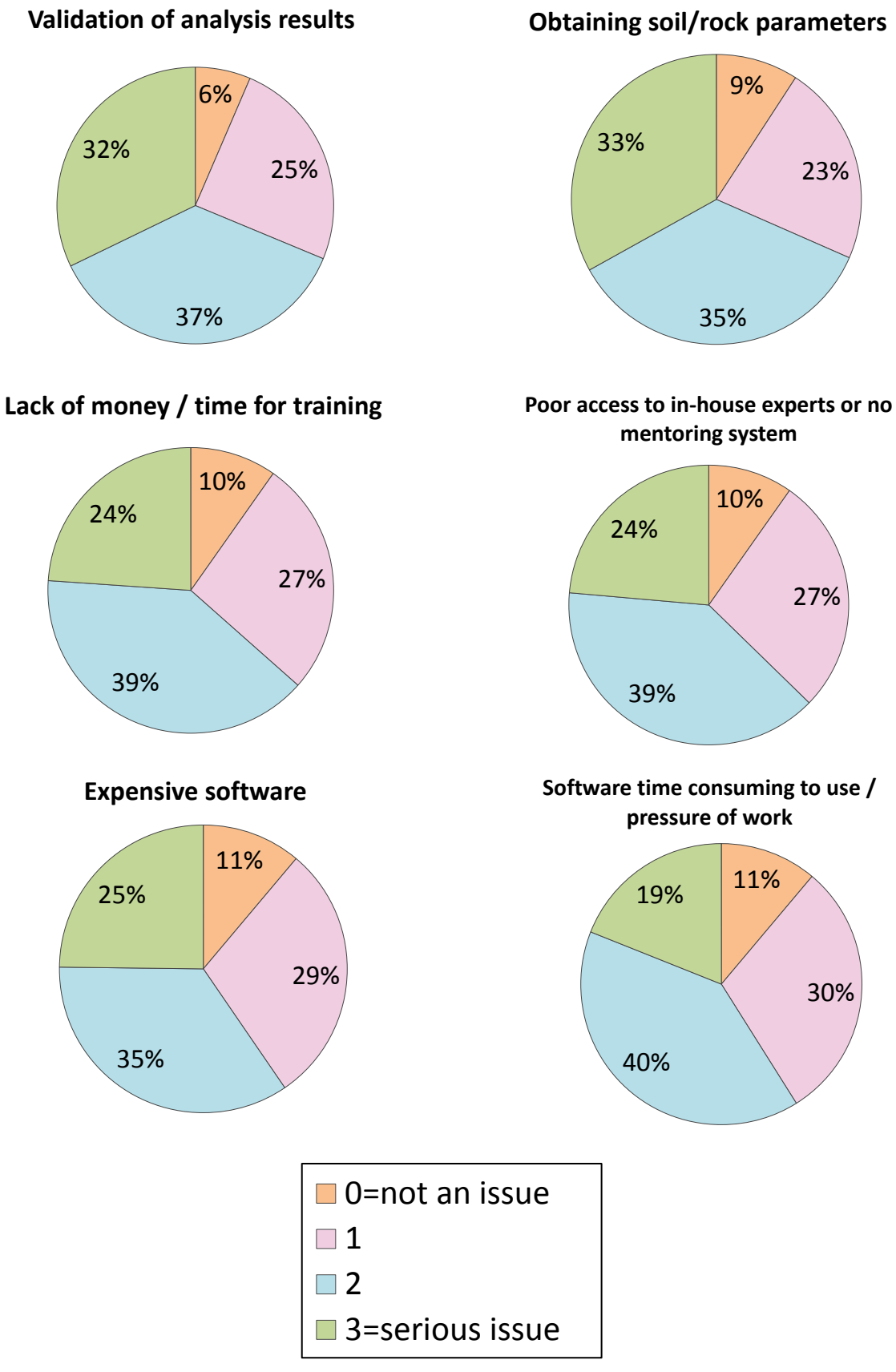

Figure A4. 17 - Valuation of each concern

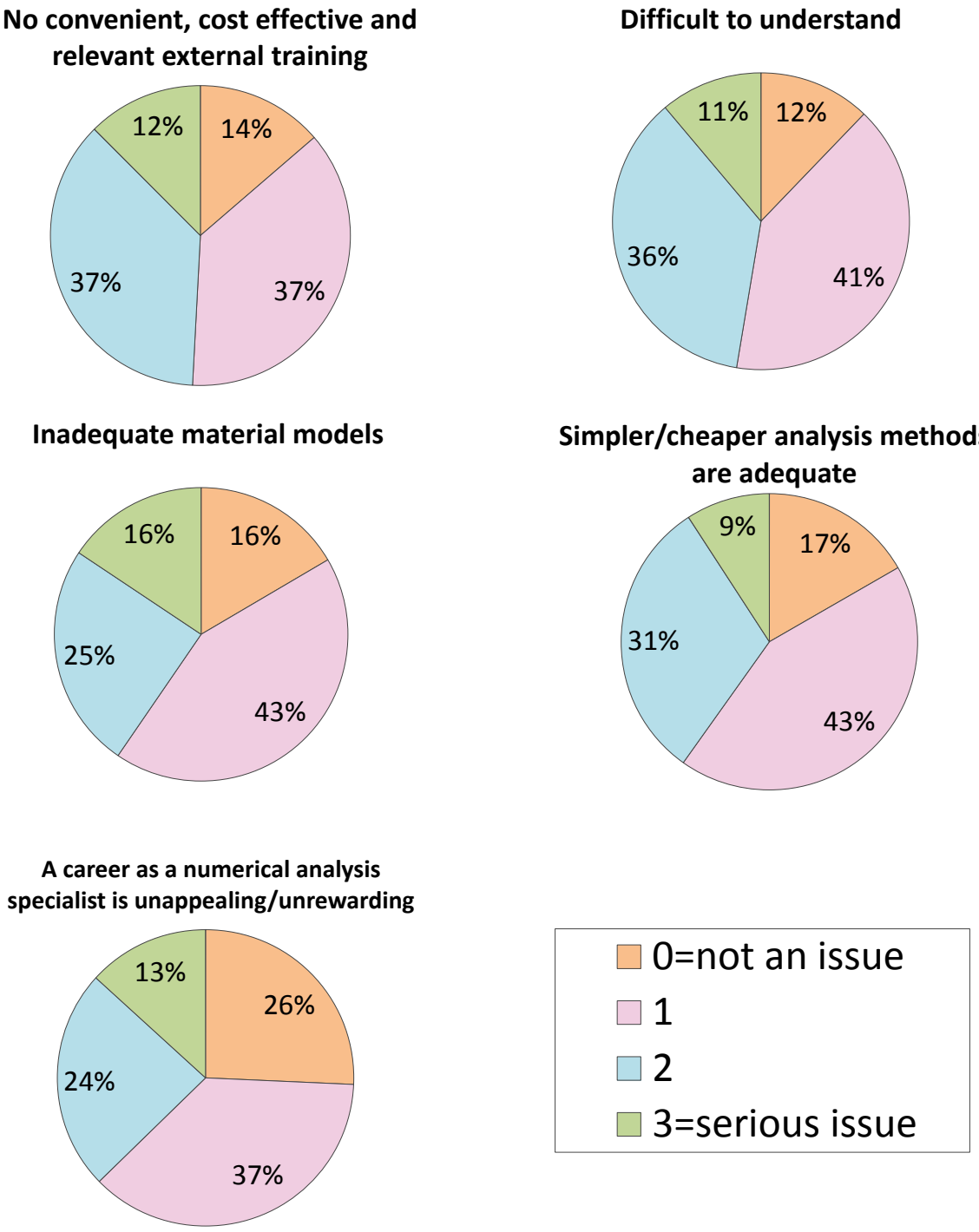

Figure A4. 18 - Valuation of each concern

Q16. In your organisation, are the competences needed to perform different geotechnical numerical analysis tasks formally defined?

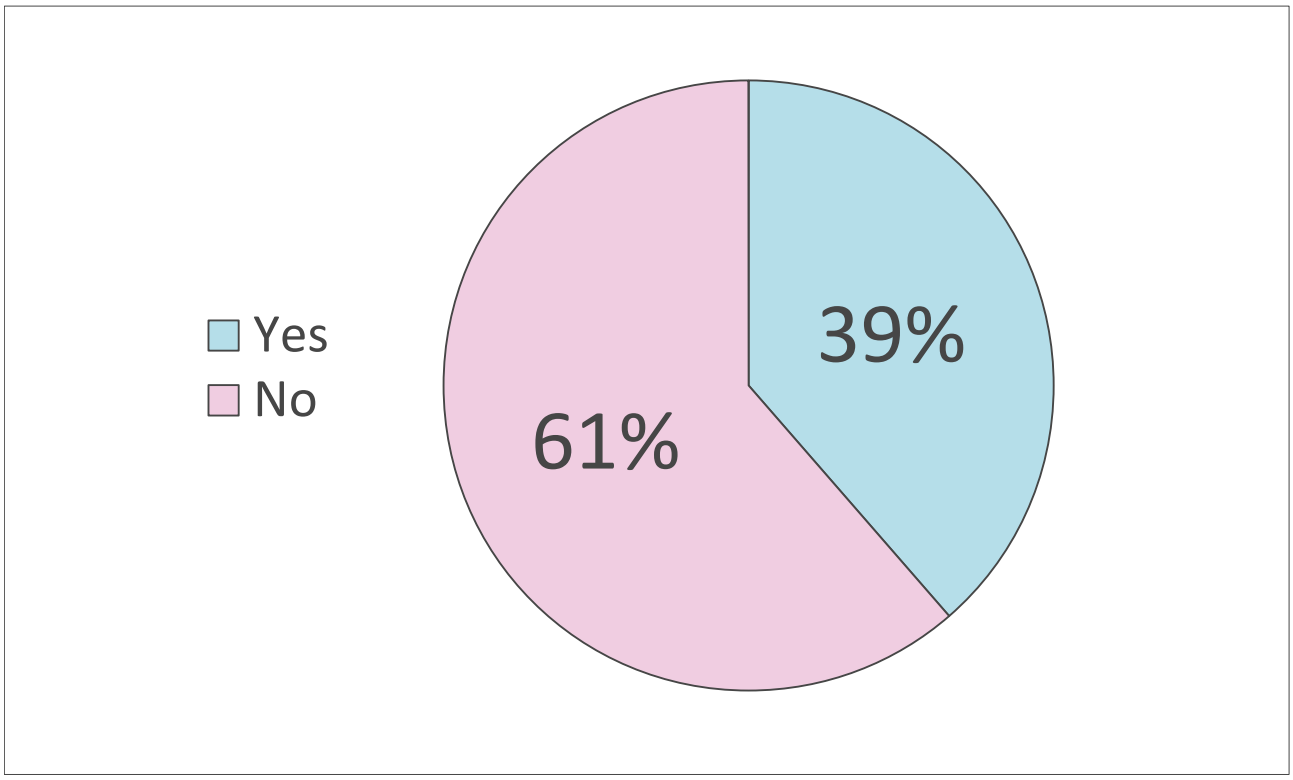

Figure A4. 19 – Are the competences to use numerical analysis are defined in your organisation?

Q17. In your organisation, is there a system for looking-up and recording staff competences in geotechnical analysis and simulation?

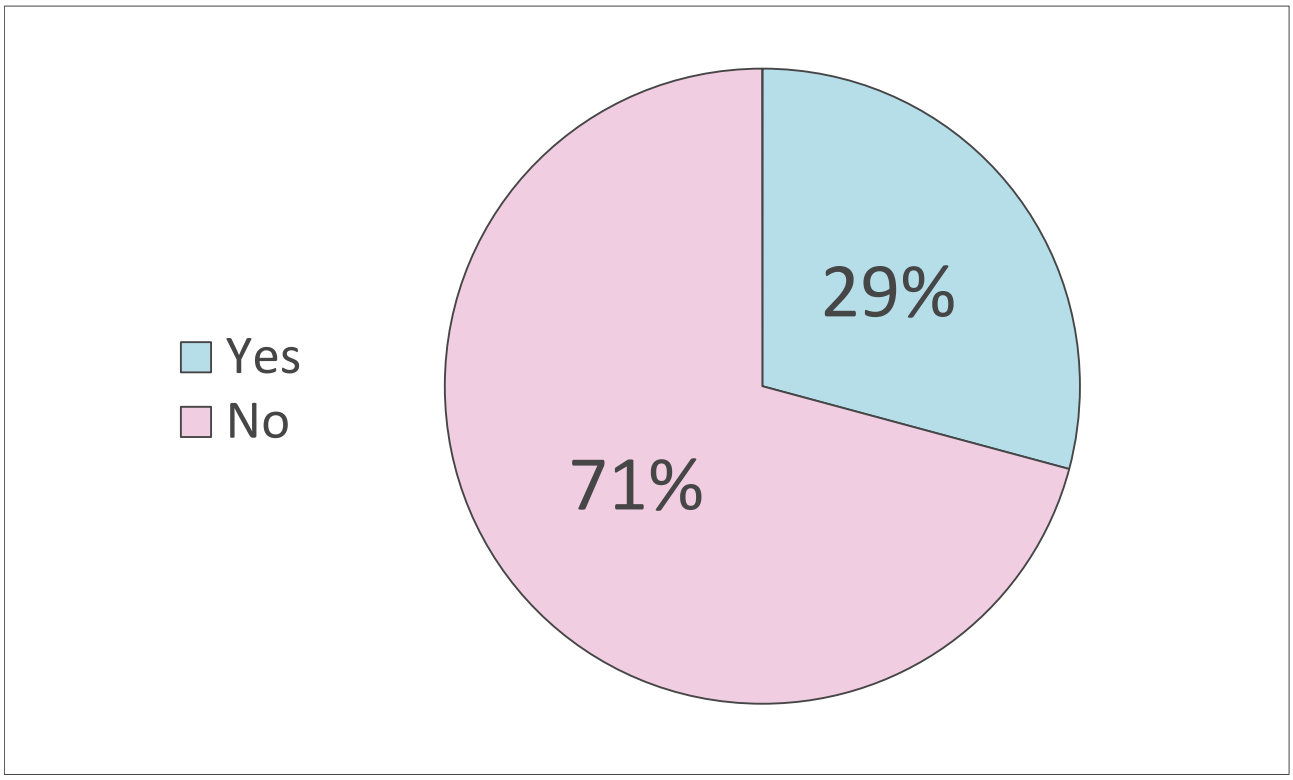

Figure A4. 20 - Does your organisation have a system for looking-up staff competences?

Q18. What medium does your company use to record analyst competences?

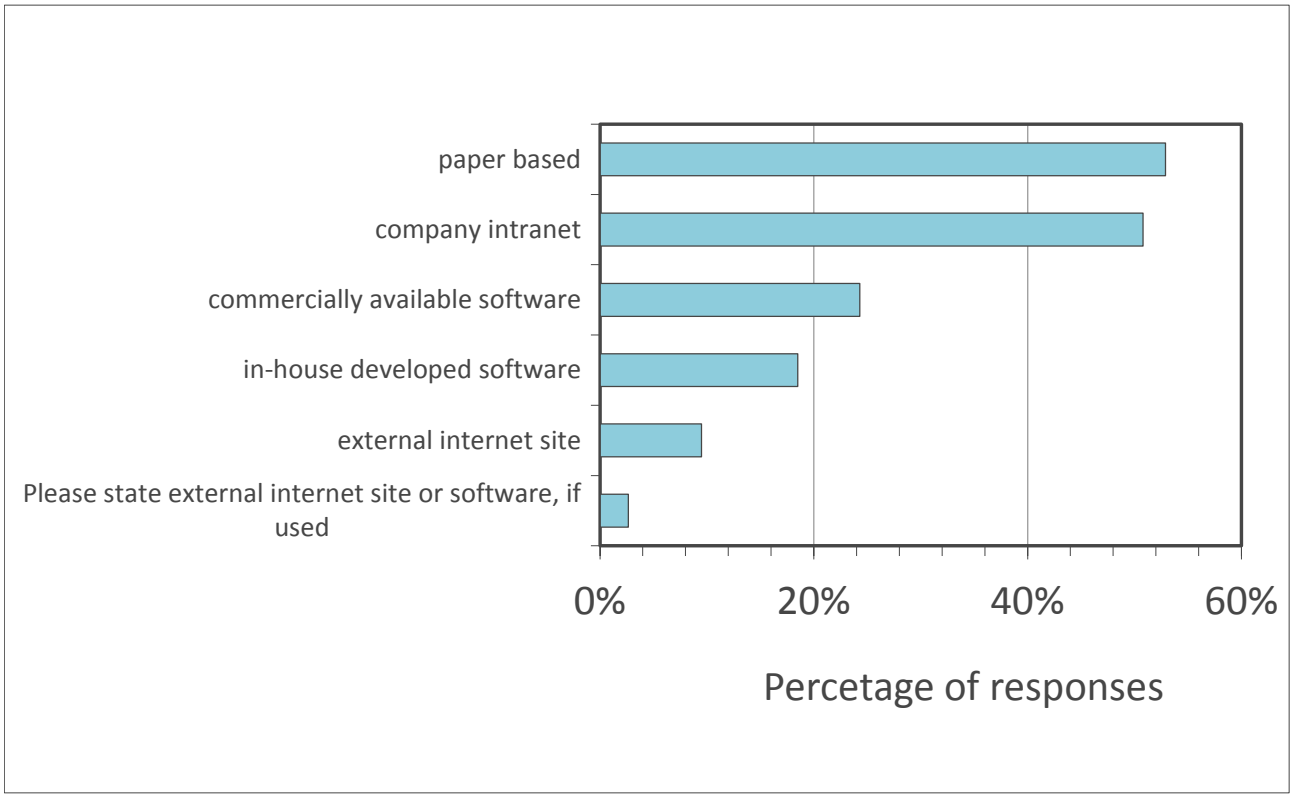

Figure A4. 21 - Medium to record skills of the staff

Q19. How many skill levels (e.g. standard, advanced) are in your existing system for recording analyst competences?

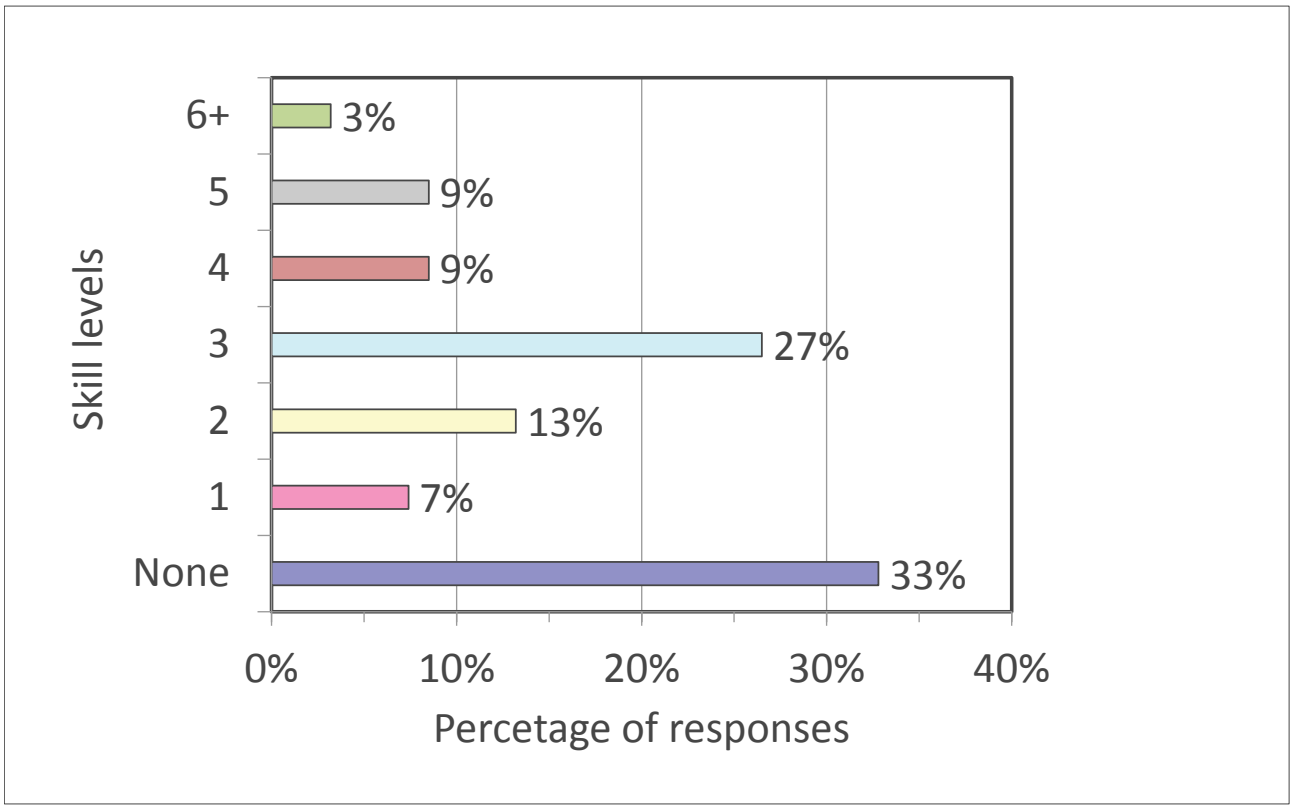

Figure A4. 22 - Number of levels of analyst competences

Q20. How are analyst competences assessed in your organisation?

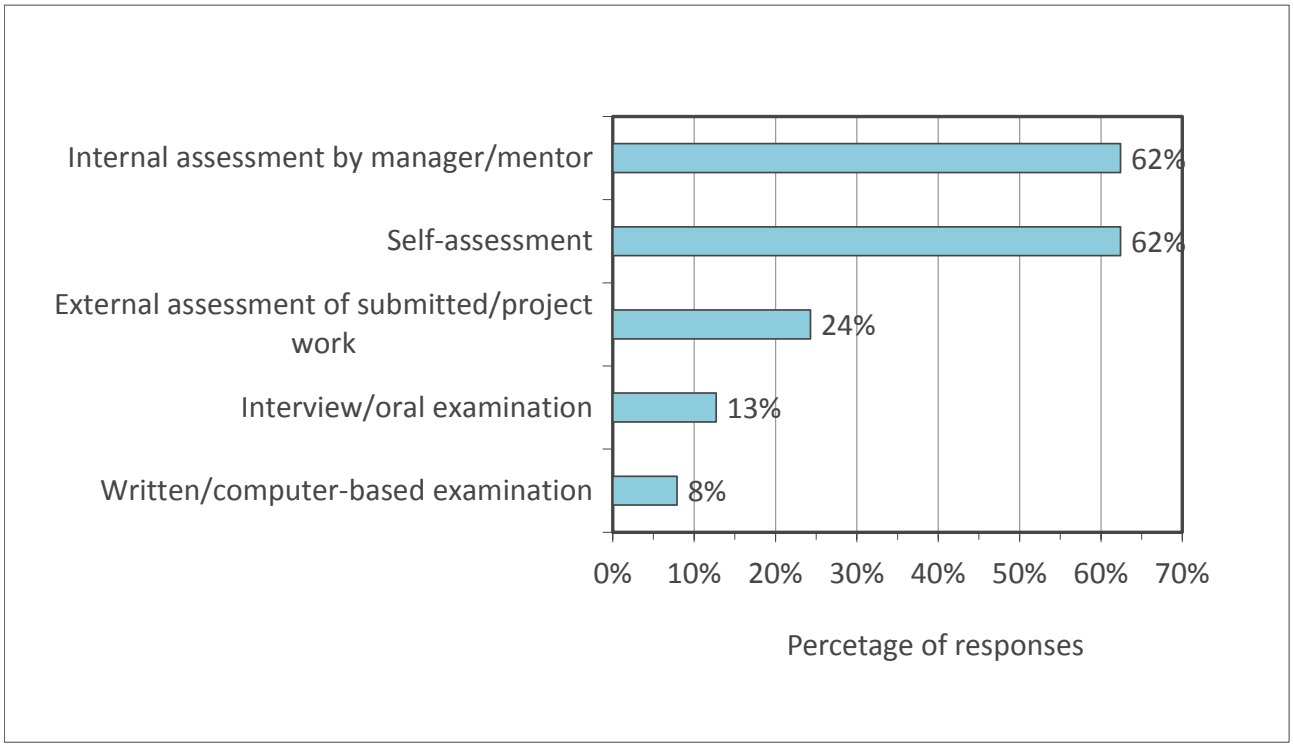

Figure A4. 23 - Analysed competences into each organisation

Q21. Do you think a system that defines competences in geotechnical numerical analysis and provides links to appropriate training resources would be useful for professional development?

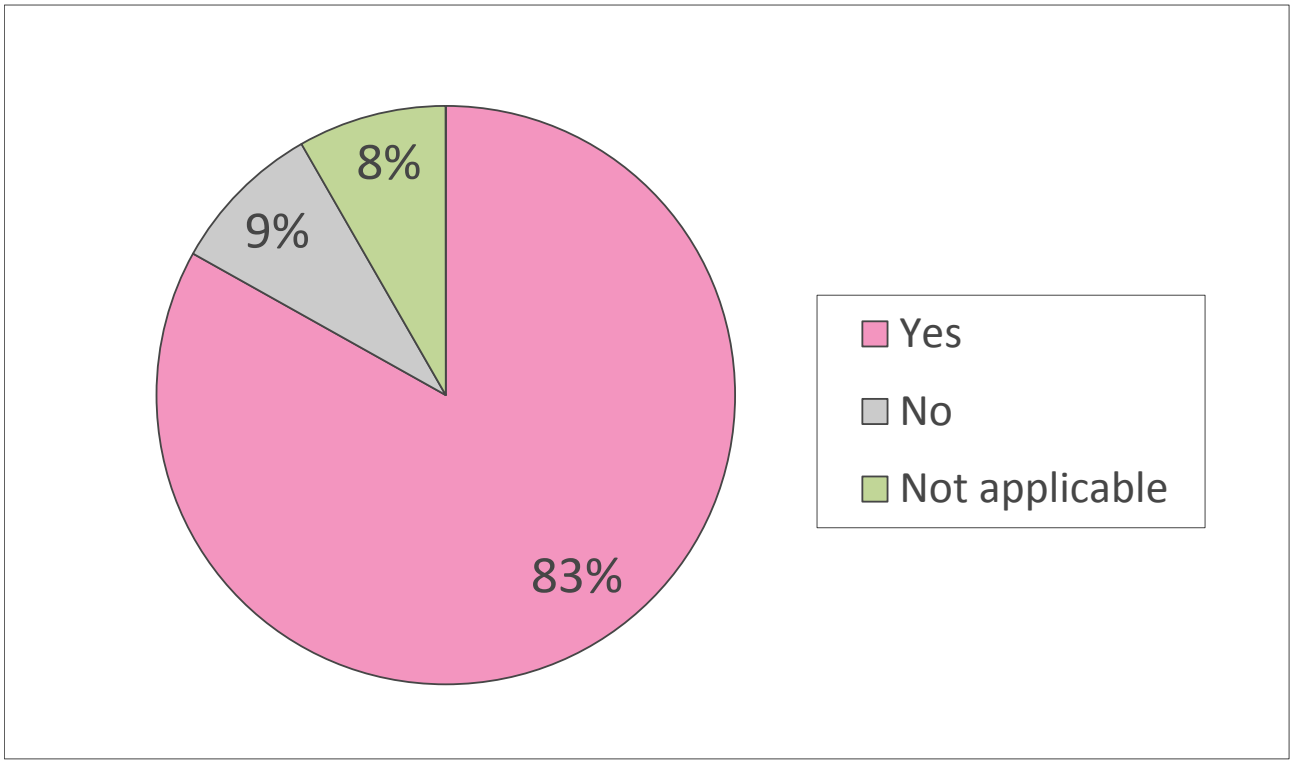

Figure A4. 24 – Is defining competences for geotechnical engineers useful?

Q22. If you are aware of any systems for defining or recording analyst competences in geotechnical numerical analysis and simulation (except in your own organisation), please provide brief details here.

Options of responses	Responses account
answered question	73
omitted question	546

Q23. How useful do you think the following mediums are for recording analyst competences?

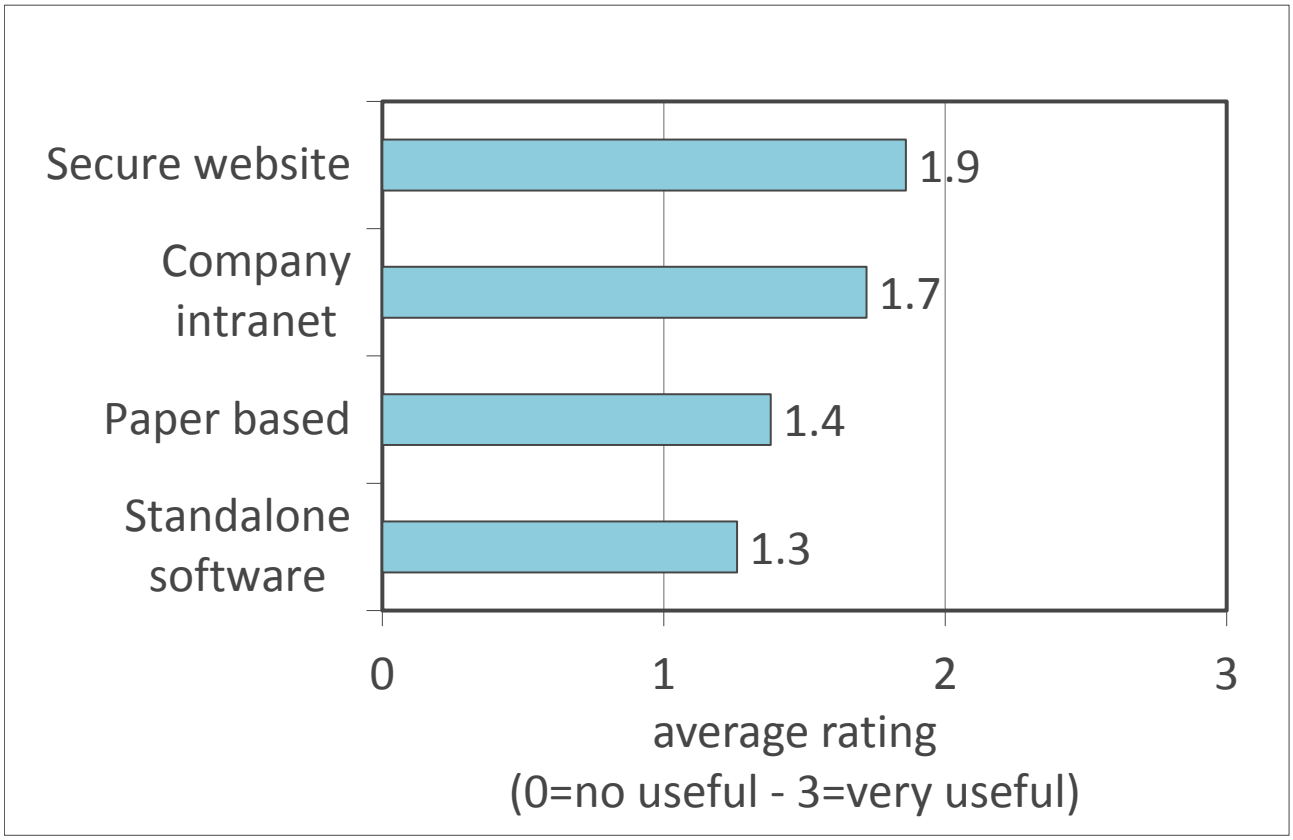

Figure A4. 25 - Usefulness of different mediums for recording analyst competences

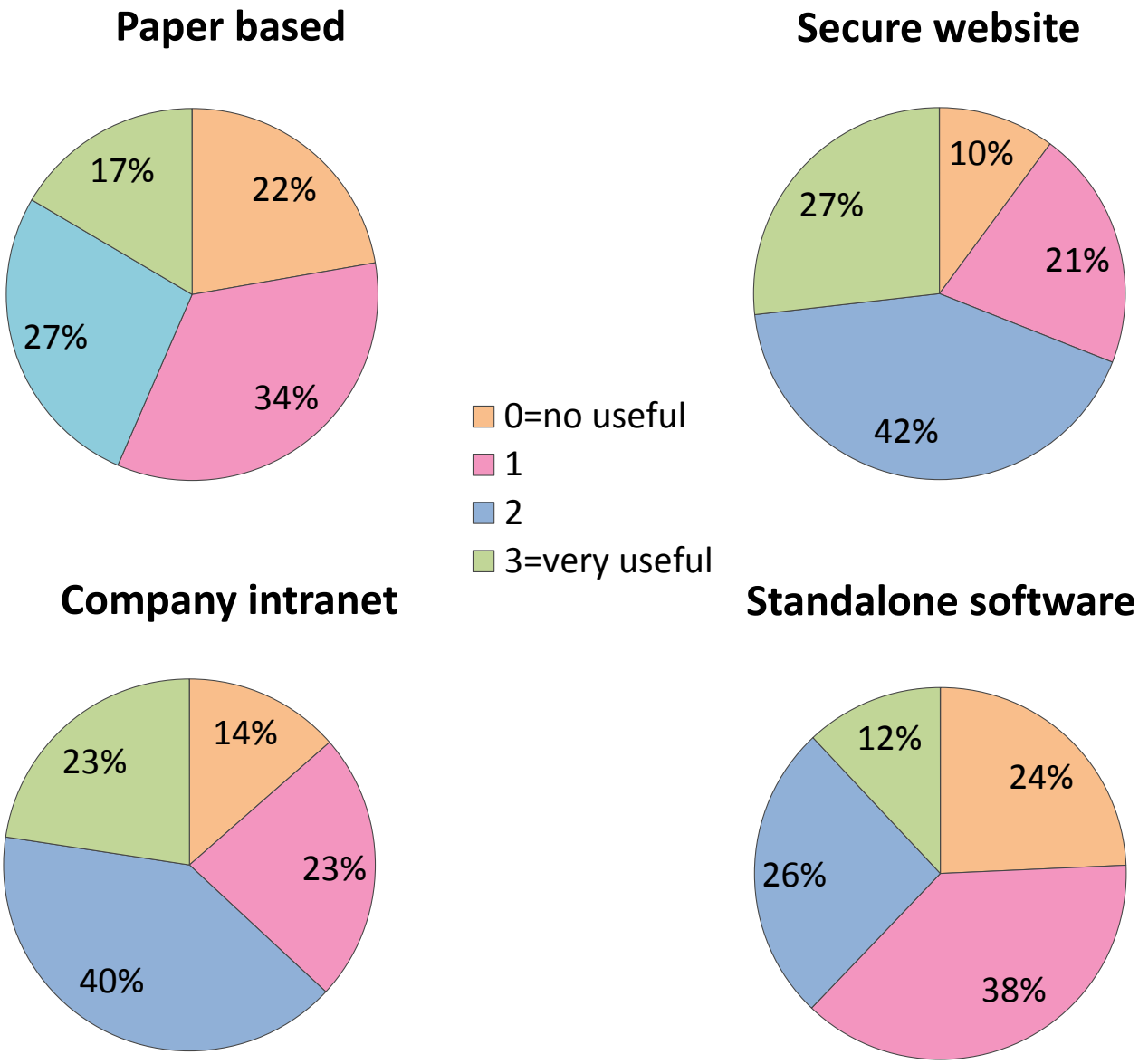

Figure A4. 26 - Rating of each means of competences assessment

Q24. How many skill levels (e.g. standard, advanced, ...) would be the most appropriate?

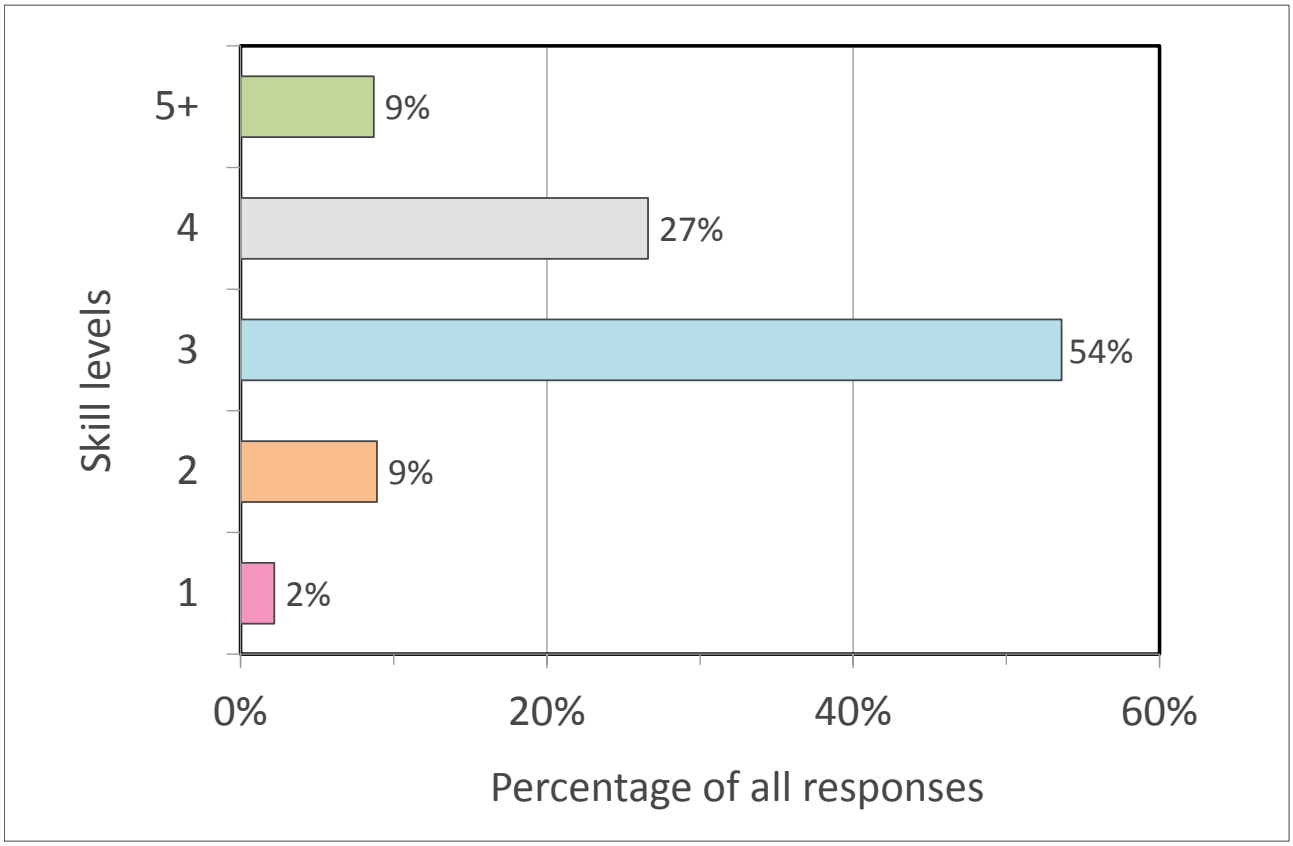

Figure A4. 27 - Number of appropriated skill levels for recoding system

Q25. Which of the areas listed below should be included in a system to define competences in geotechnical numerical analysis?

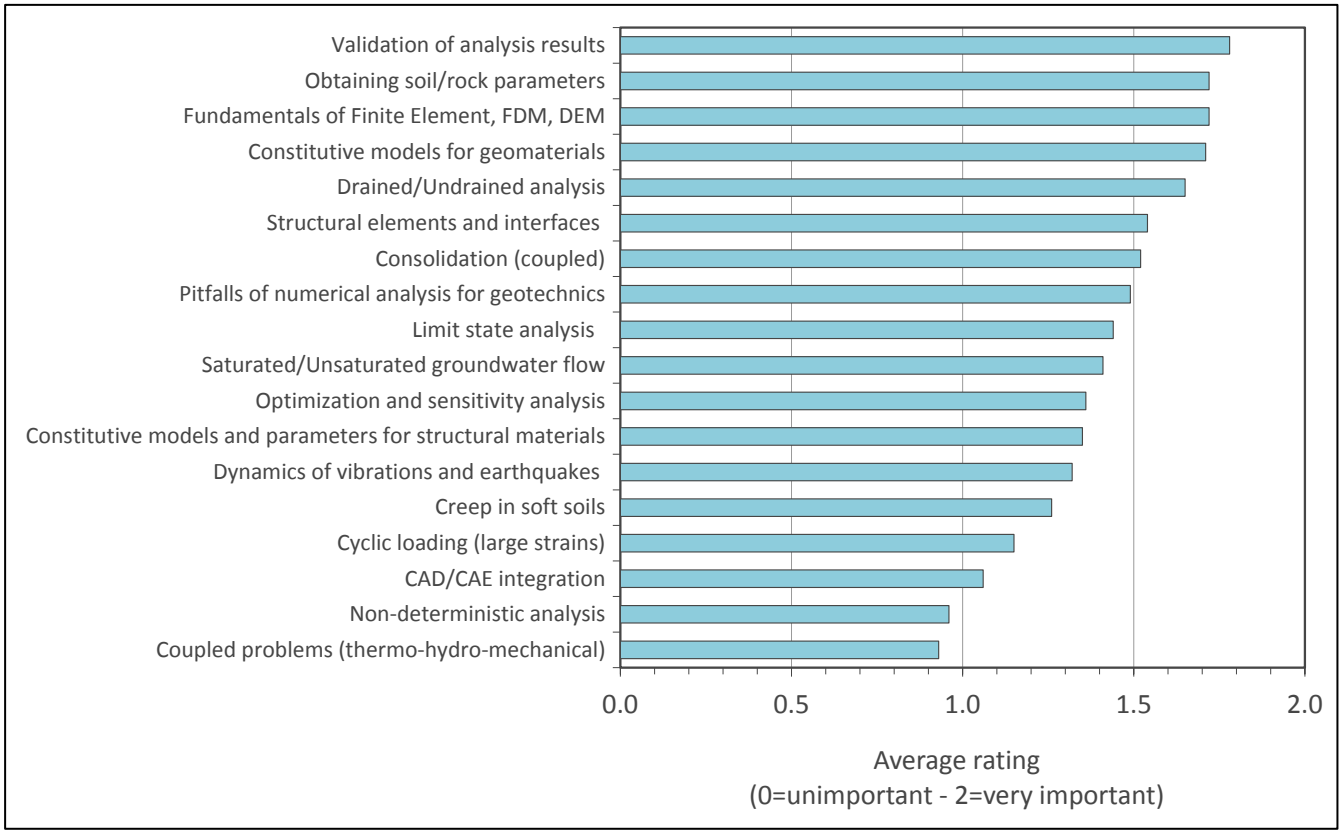

Figure A4. 28 - Geotechnical Knowledge Areas for defining competences

Rating of each geotechnical areas:

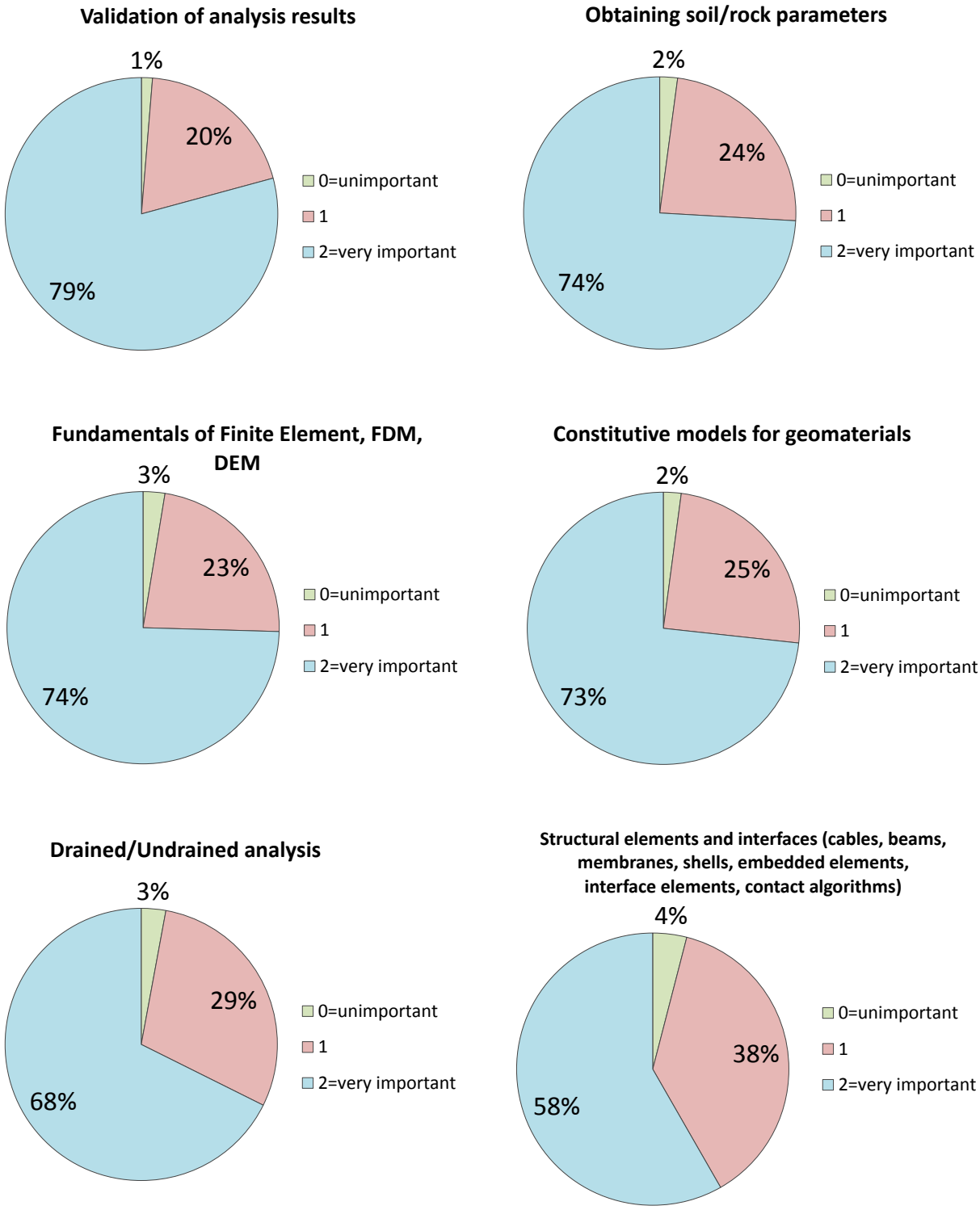

Figure A4. 29 - The most important areas considered by respondents (rating >1.5)

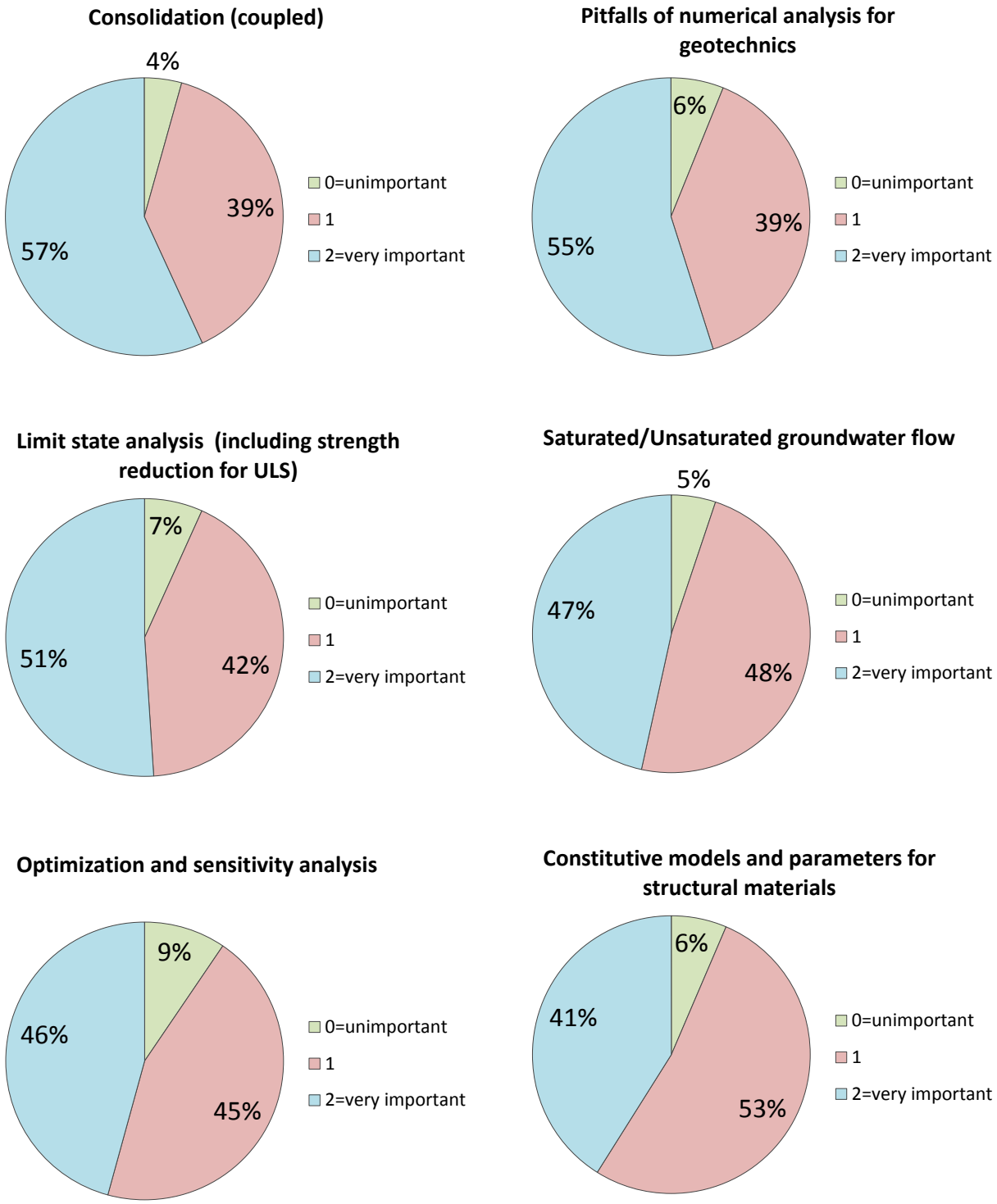

Figure A4. 30 - Geotechnical areas assess between 1 and 1.5 by the respondents

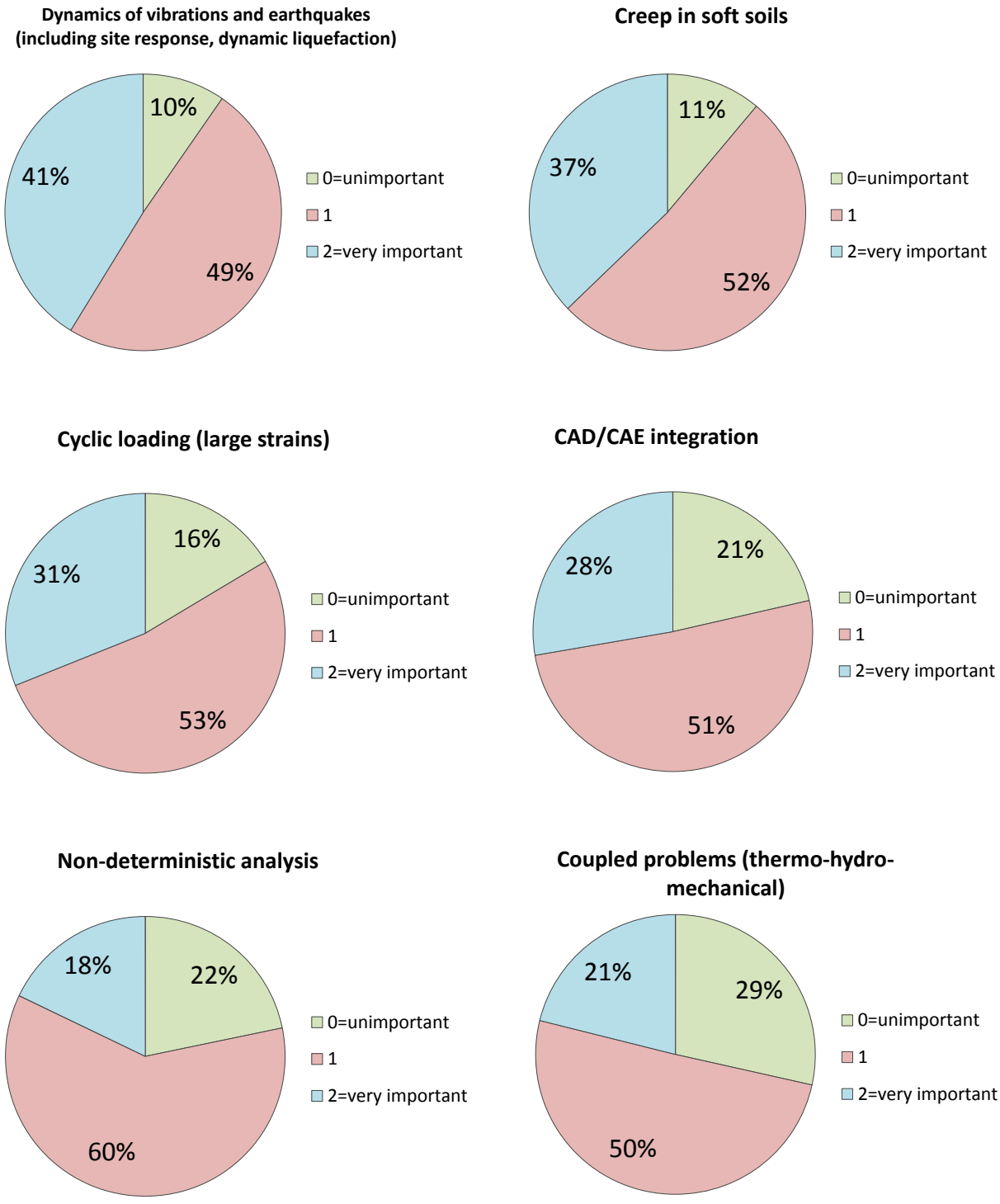

Figure A4. 31 - Geotechnical areas assess between 1 and 1.3 by the respondents

Q26. The competences to be defined covering the areas described above should be focussed in which of the following categories?

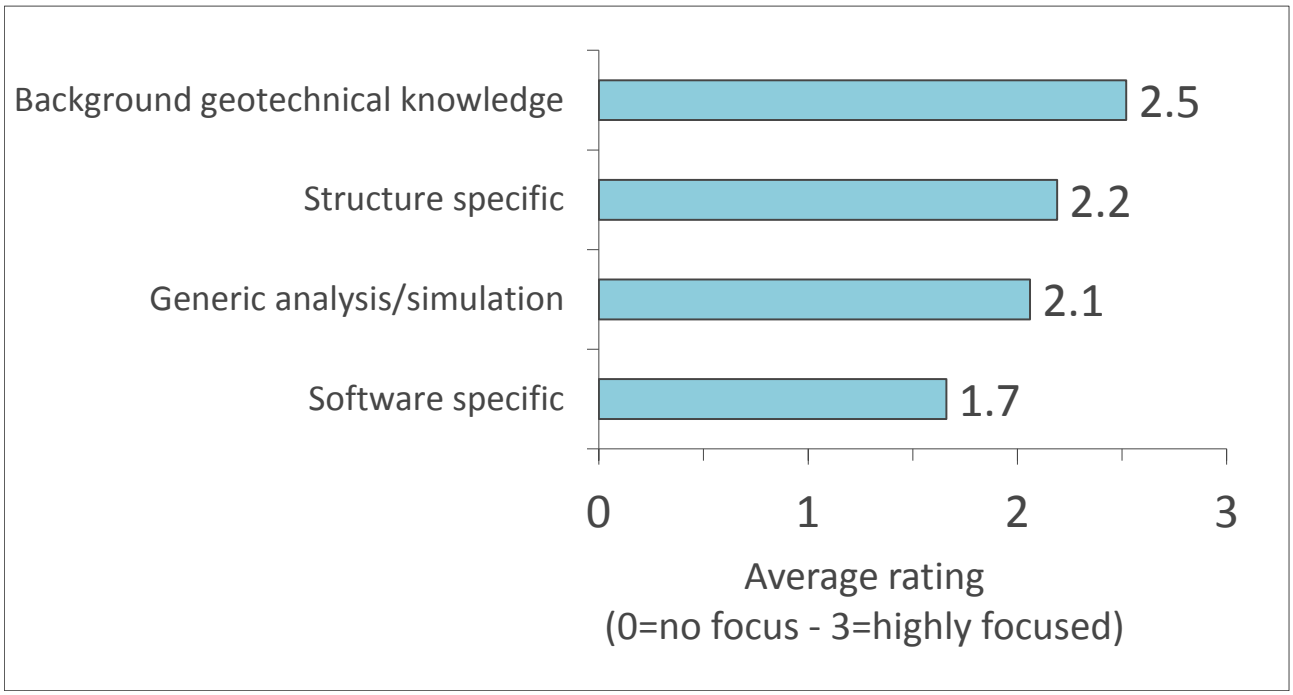

Figure A4. 32 - Geotechnical Knowledge Categories

Rating of each Geotechnical Category:

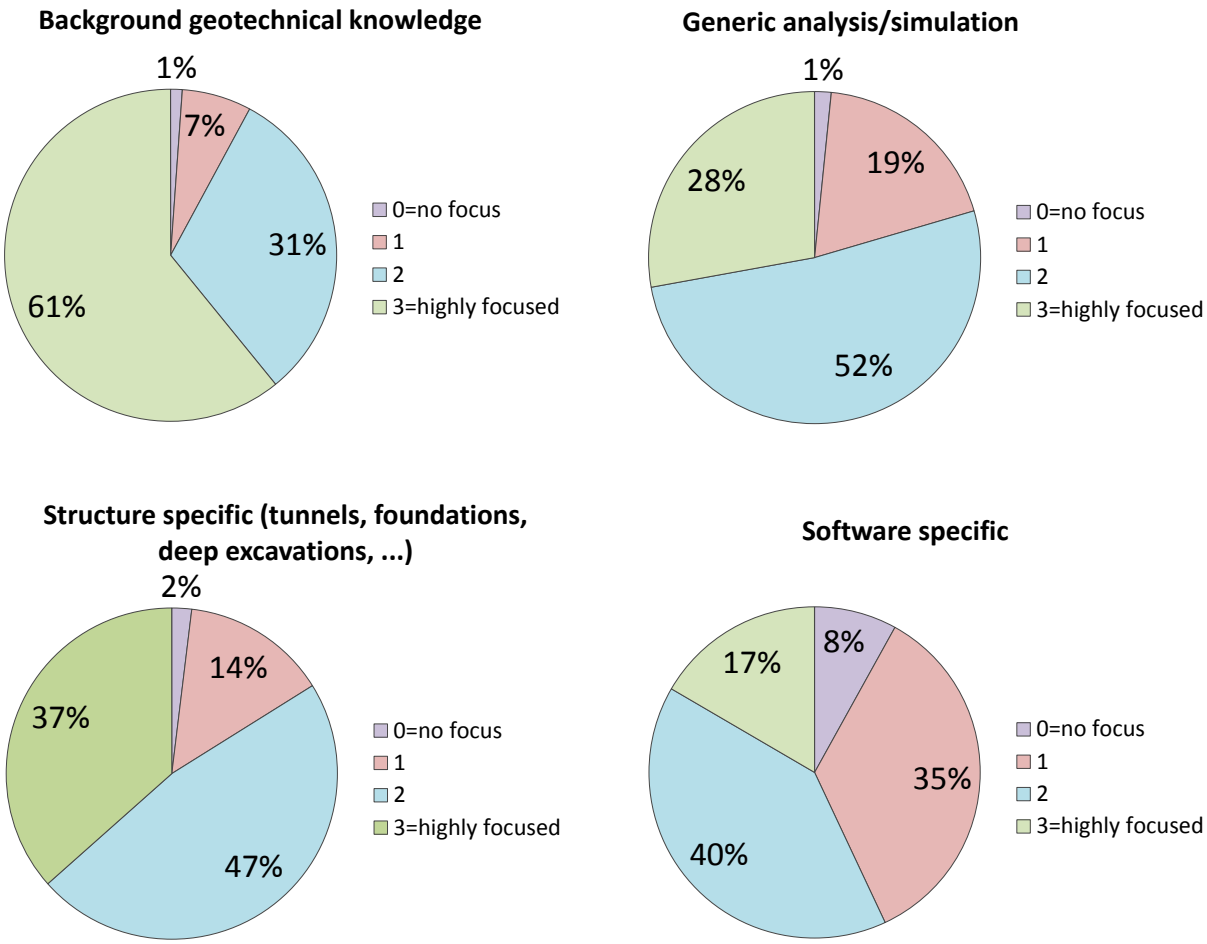

Figure A4. 33 - Rating of each Geotechnical Category

Q27. From your experience, rate the usefulness of the following learning methods in geotechnical numerical analysis:

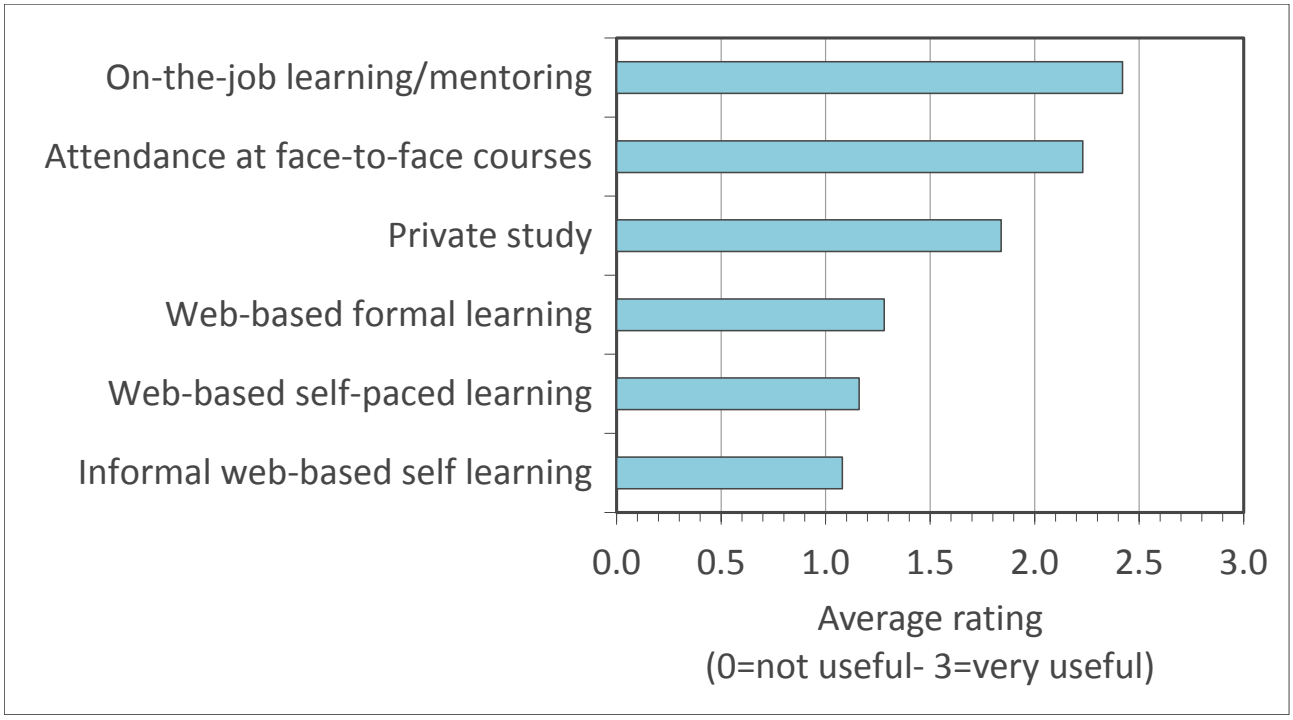

Figure A4. 34 - Learning methods for geotechnical numerical analysis

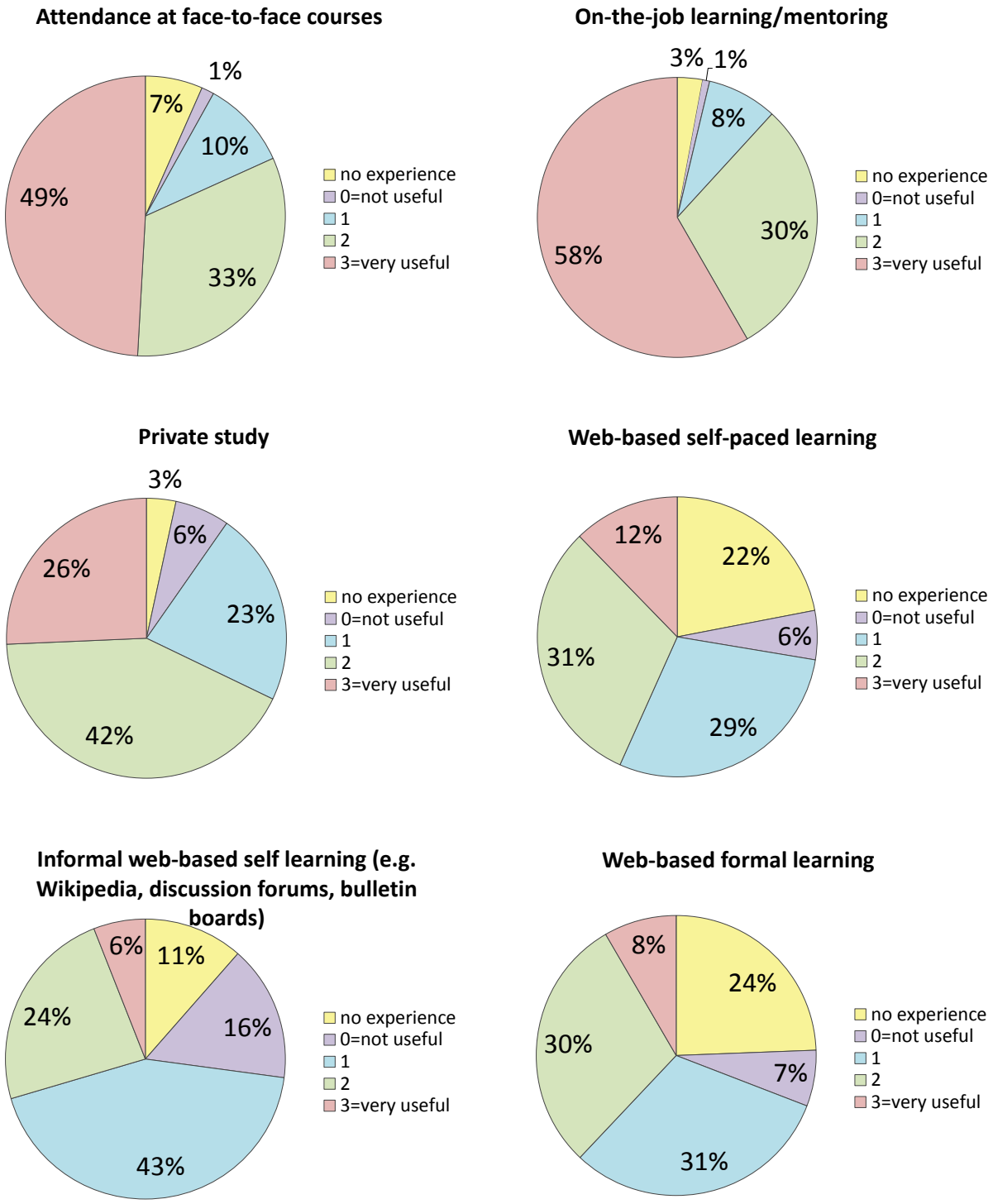

Figure A4. 35 - Rating of each learning methods by the respondents

Q28. In which of the following fields would you like to see the COGAN project develop E-Learning modules next year

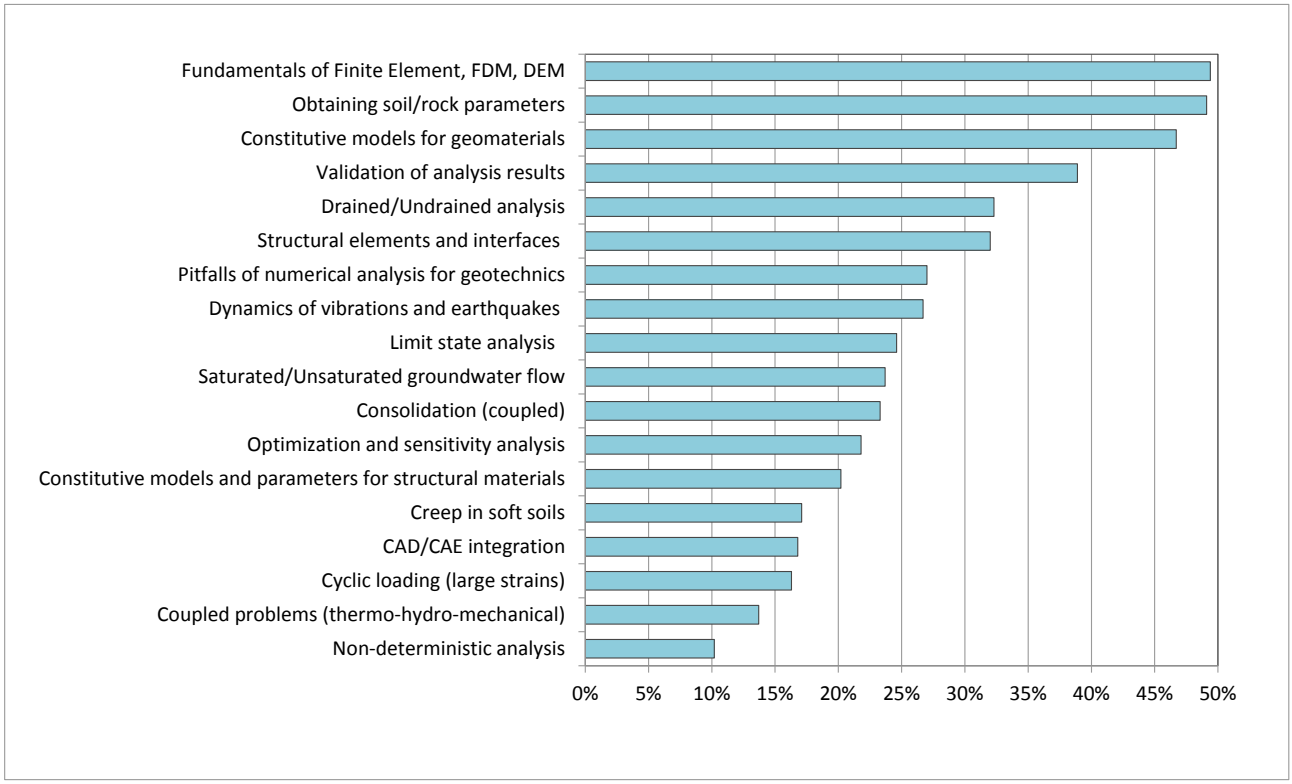

Figure A4. 36 - E-Learning modules

Q29. Would you be willing to evaluate some deliverables of the COGAN project? This might involve a simple road-test of a product or a more technical review

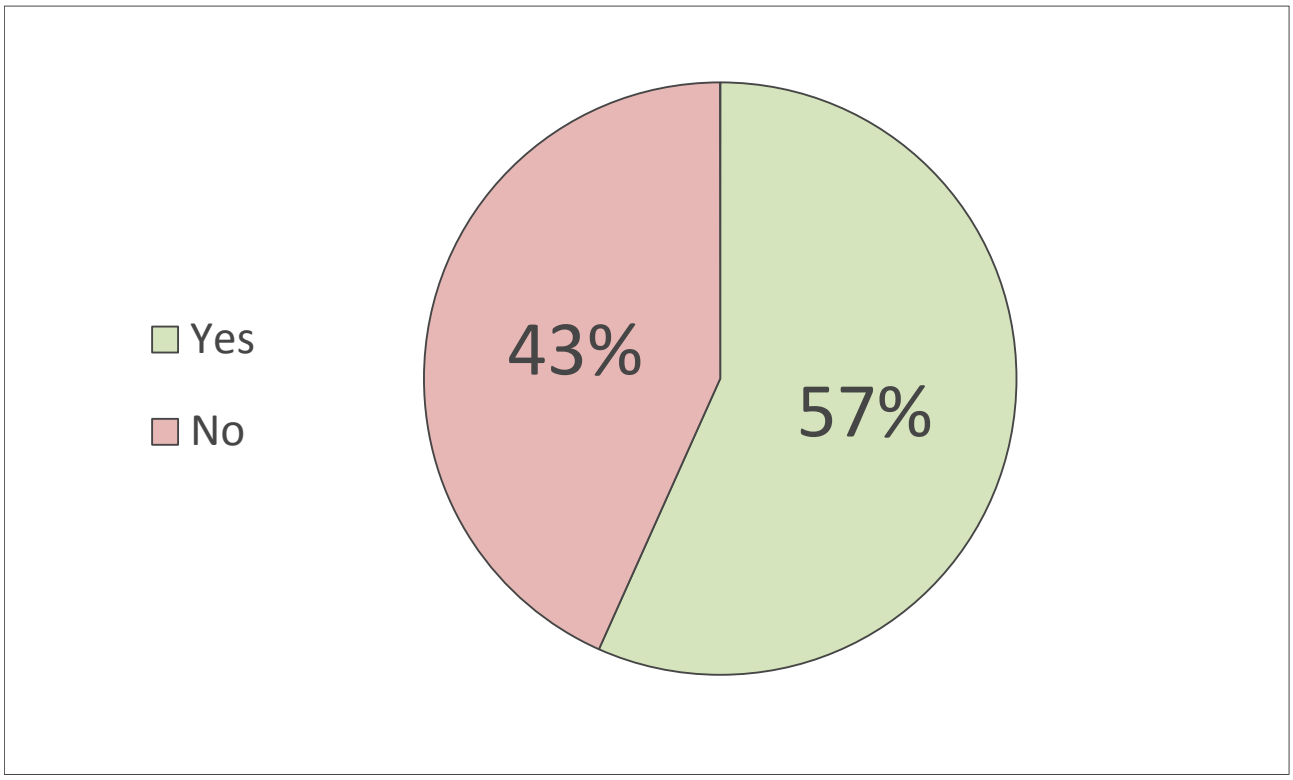

Figure A4. 37 - Percentage of respondents who would like to evaluate some deliverables of the COGAN project

APPENDIX 4 – COMPARISON OF RESULTS BY COUNTRY

Q2.Age of respondents

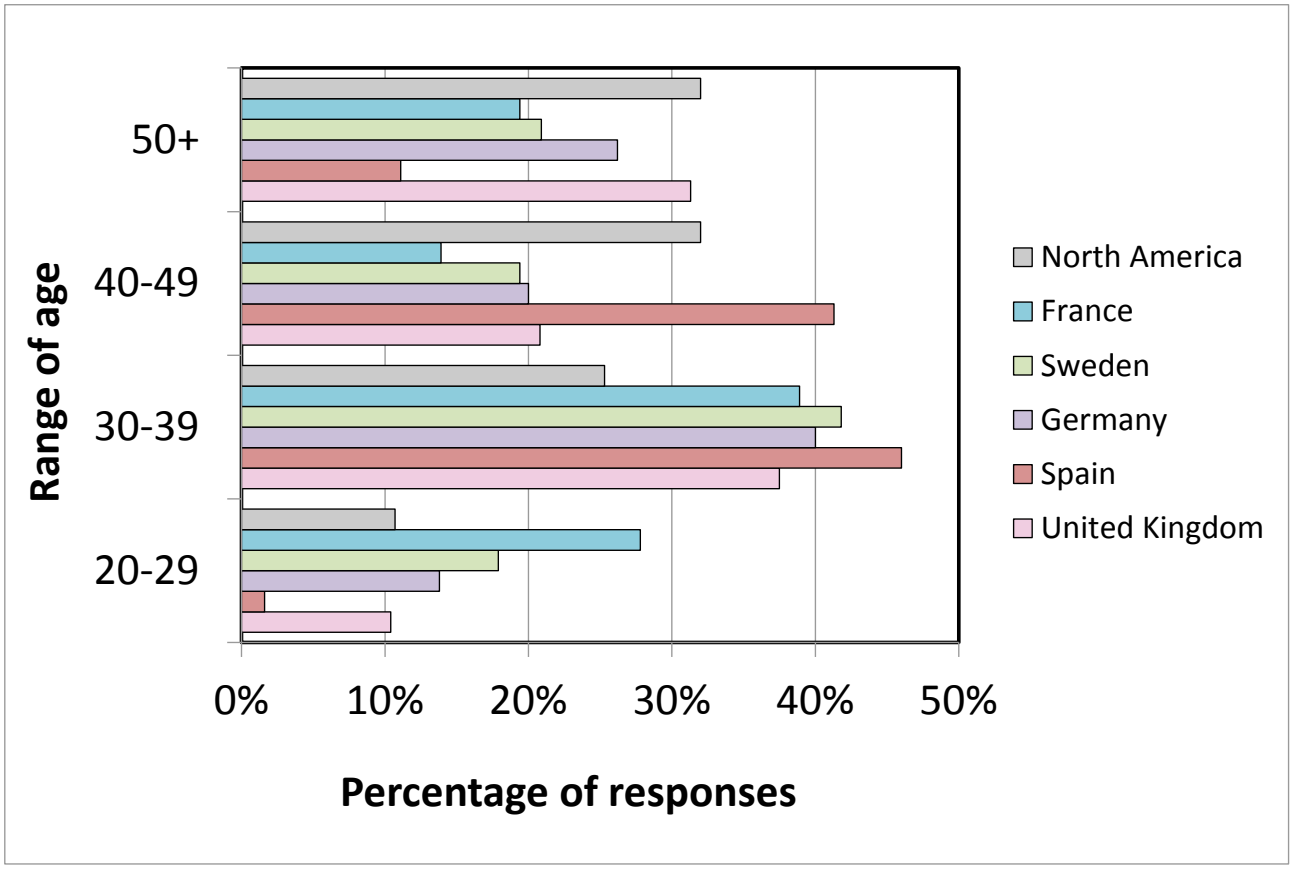

Figure A5. 1 – Age of respondents

Q3.Position of respondents

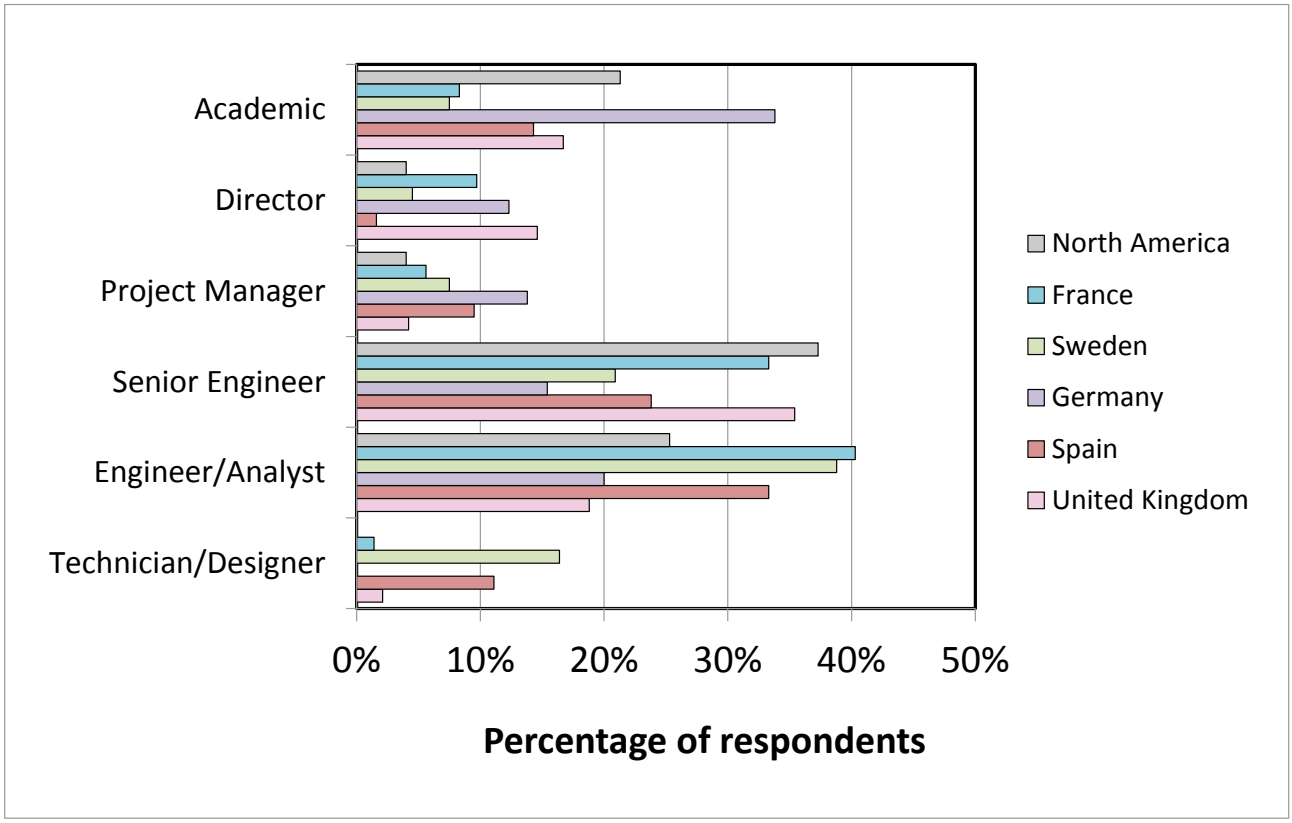

Figure A5. 2 – Position of respondents

Q4.Higher education (EQF levels)

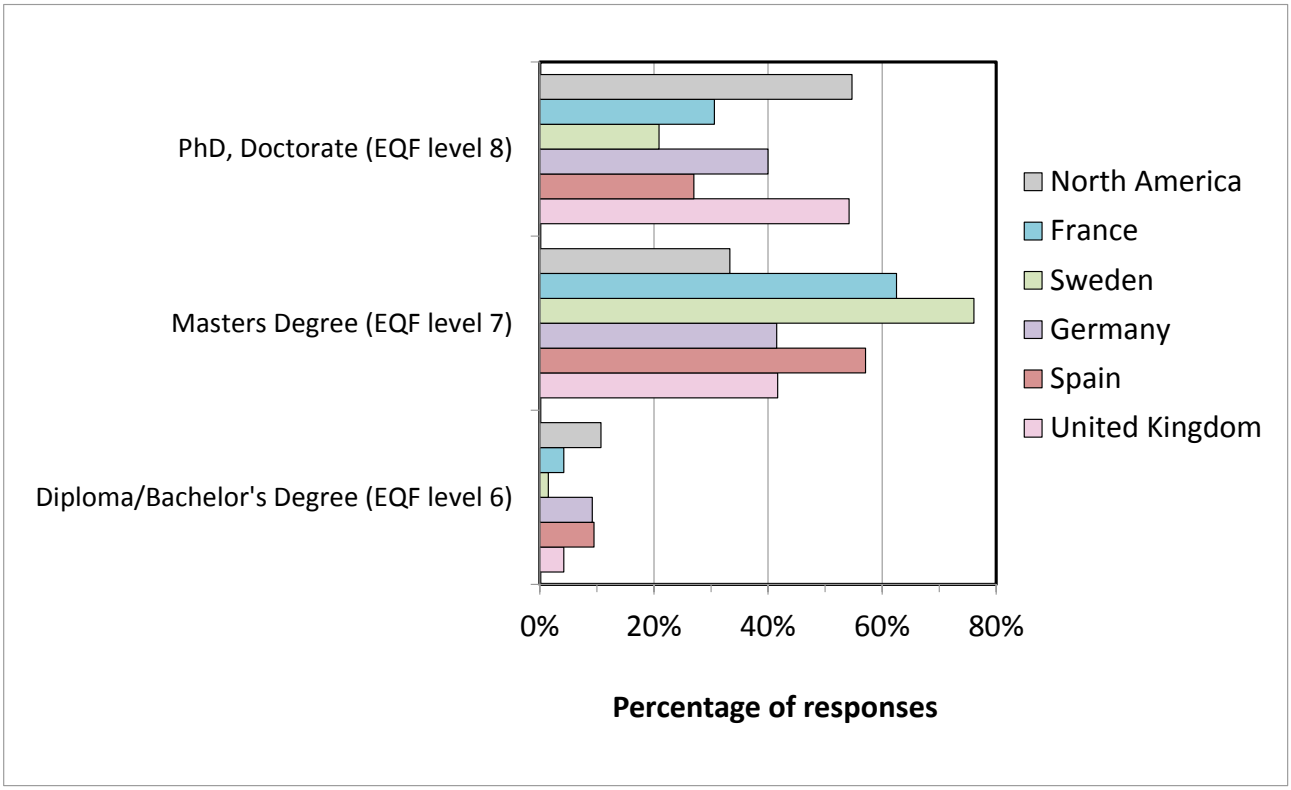

Figure A5. 3 – Education levels of respondents

Q5. How long have you been involved in geotechnical numerical analysis and simulation?

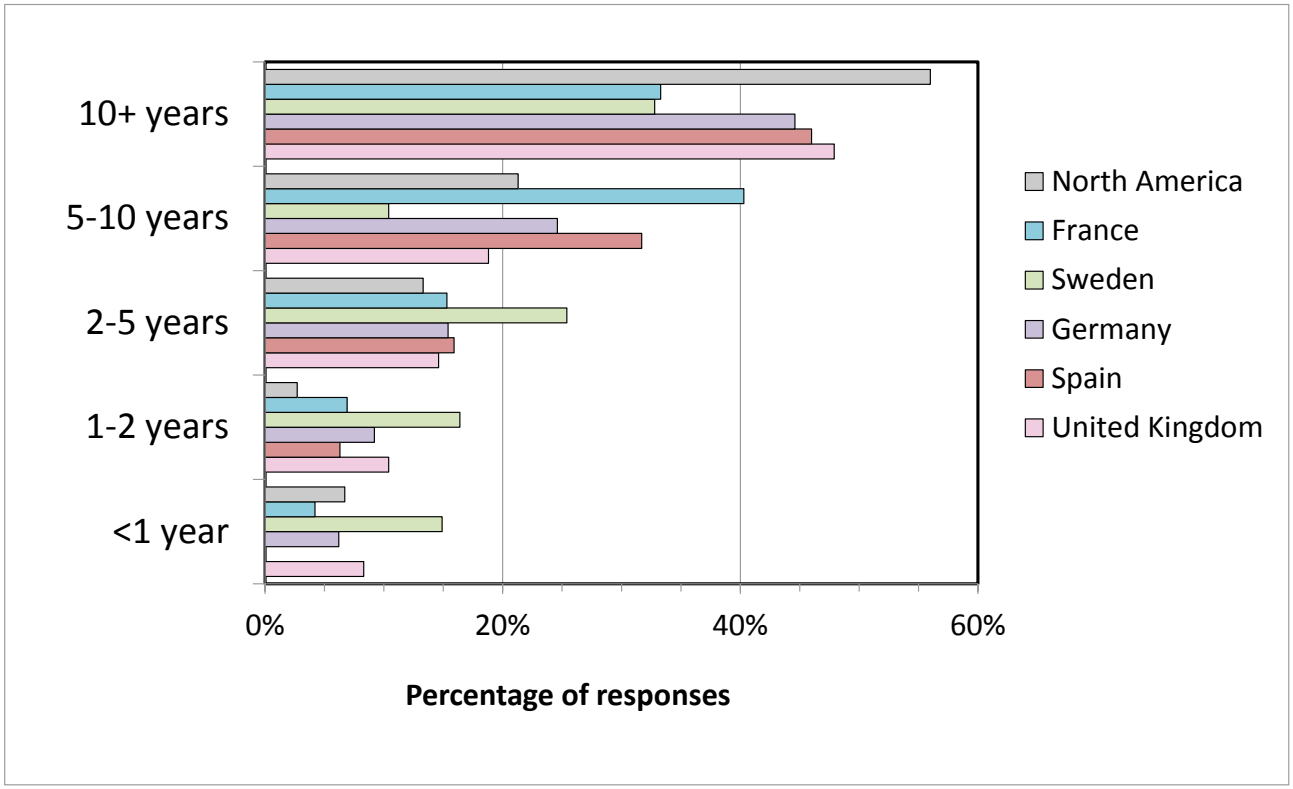

Figure A5. 4 – Time dedicated at geotechnical numerical analysis

Q6. Over the past 6 months, what percentage of your working time has been spent involved in geotechnical numerical analysis and simulation?

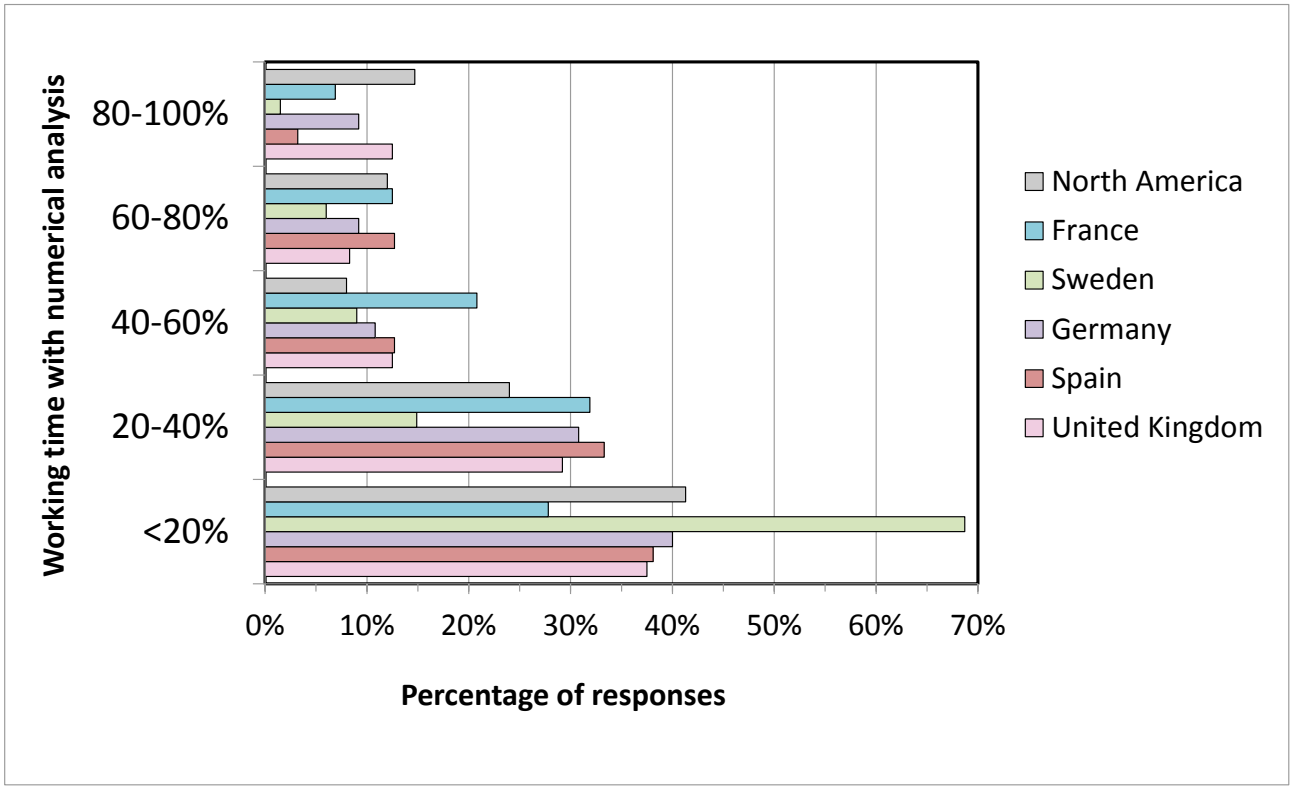

Figure A5. 5 – Working time spent in geotechnical numerical analysis

Q7. How does your university education relate to your numerical analysis and simulation activity (where 0=not related and 3=fully related)?

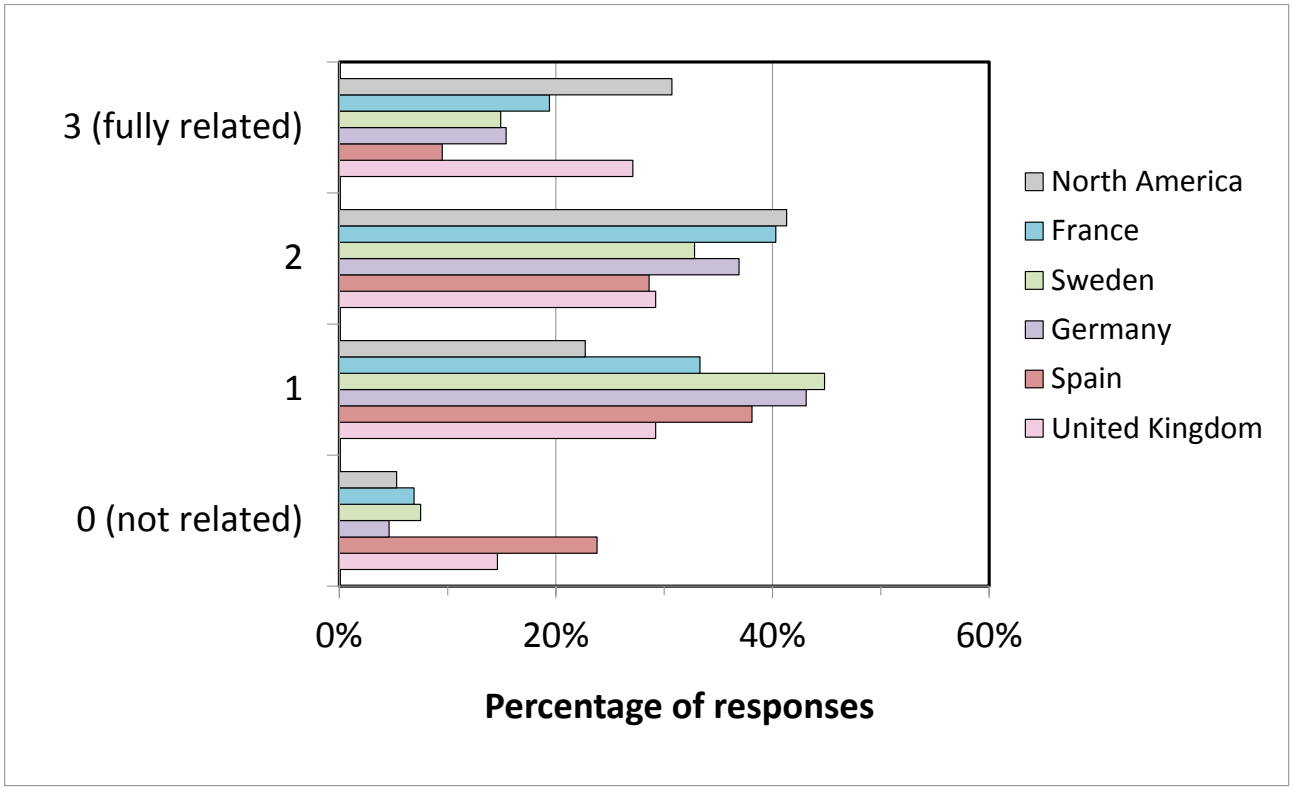

Figure A5. 6 – Relation between university education and numerical analysis

Q8. Nature of organisation

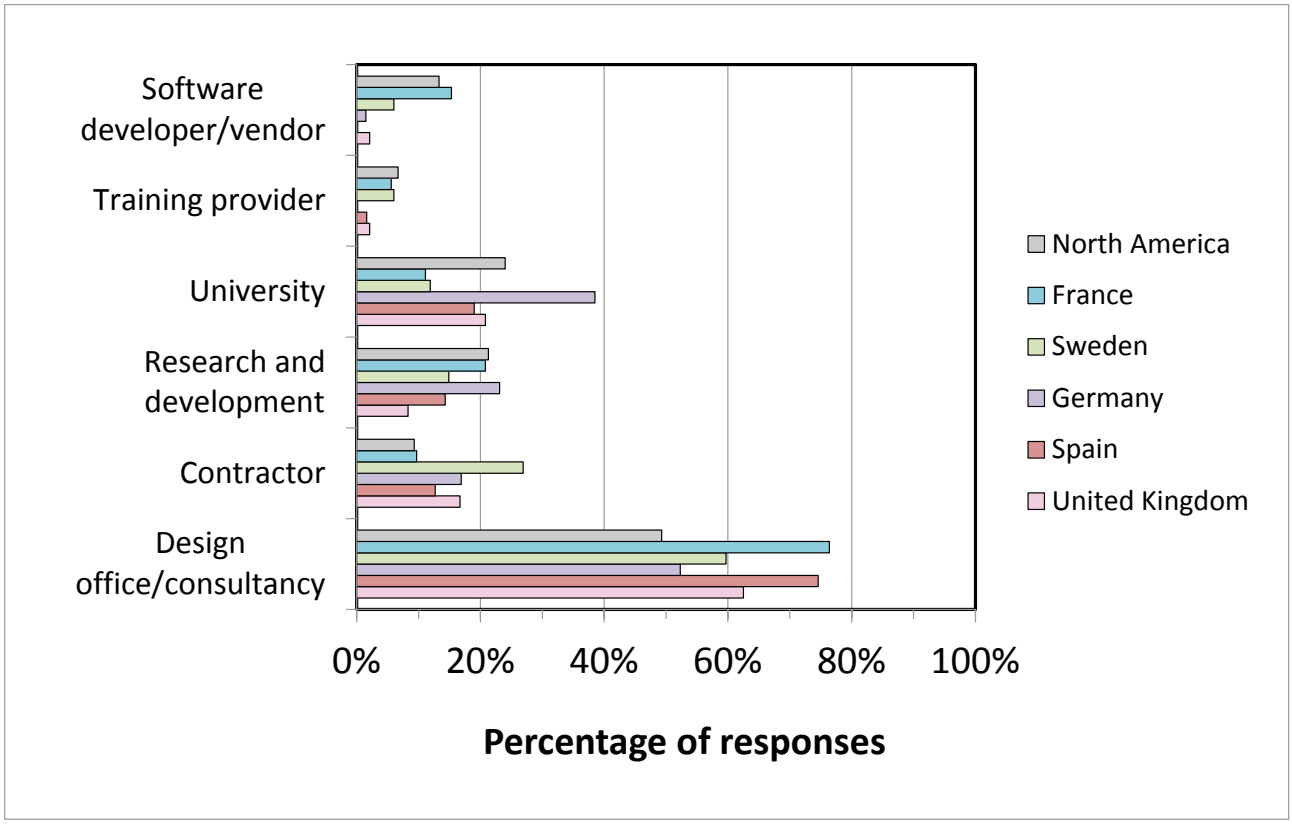

Figure A5. 7 – Nature of organisation

Q9. Industry sector

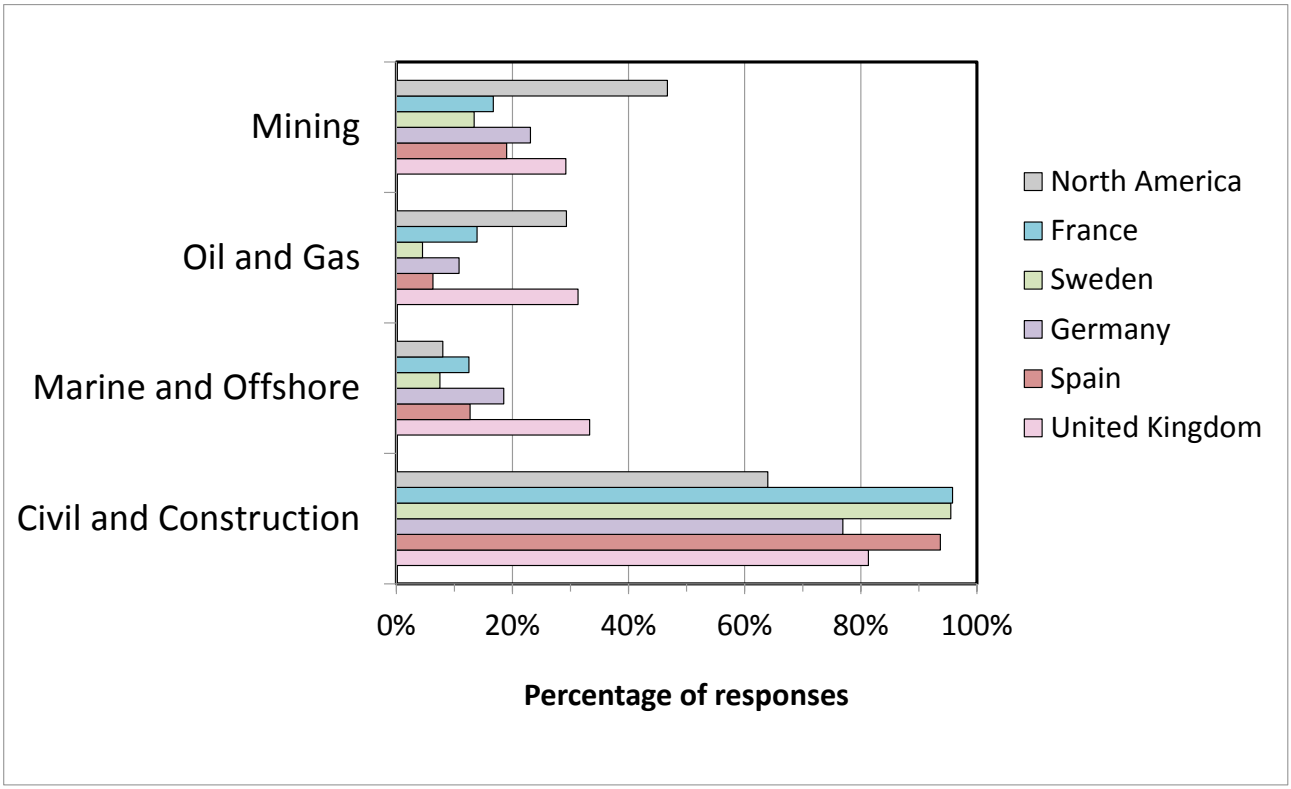

Figure A5. 8 – Industry sector

Q10. Size of organization

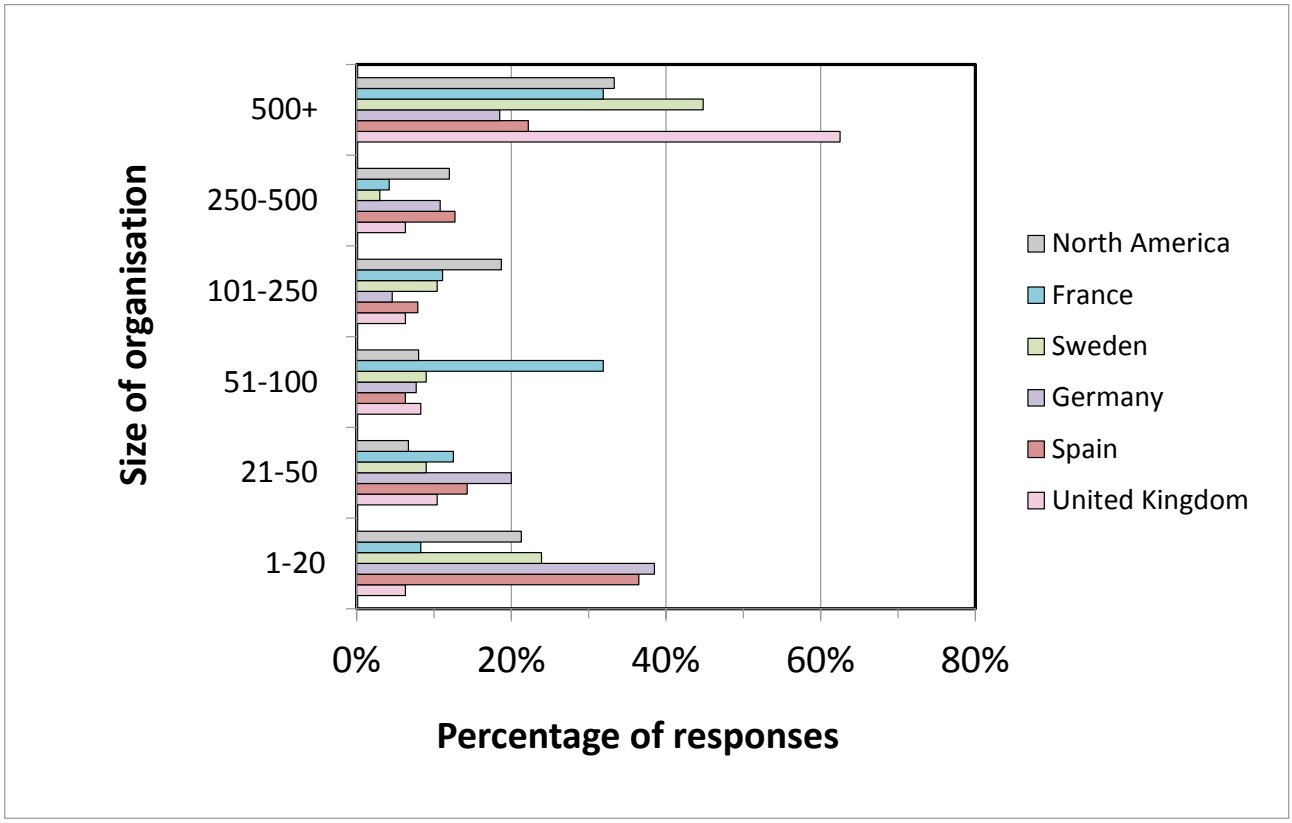

Figure A5. 9 – Size of organization

Q11. Number of people using geotechnical numerical analysis and simulation tools in your organisation

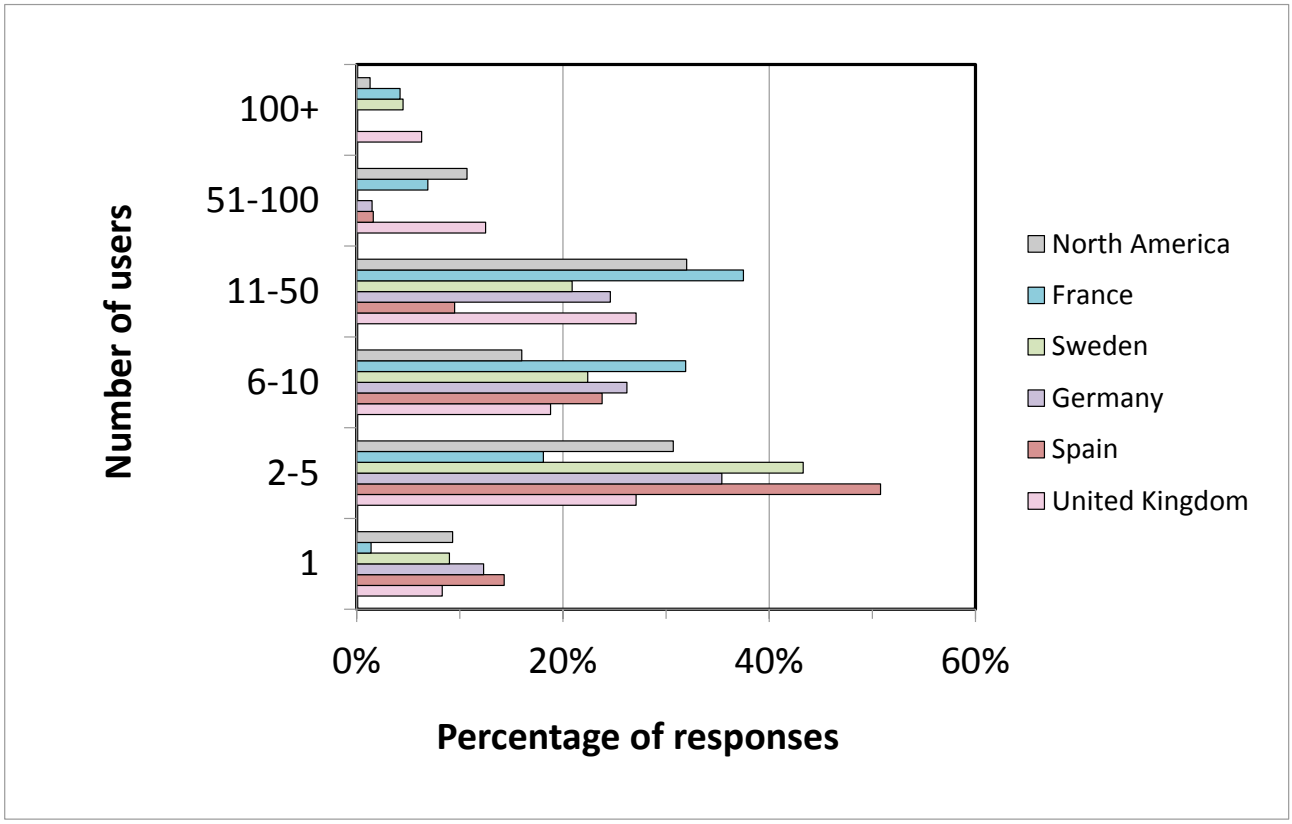

Figure A5. 10- Number of numerical analysis users

Q12. The software you use for geotechnical numerical analysis and simulation is :

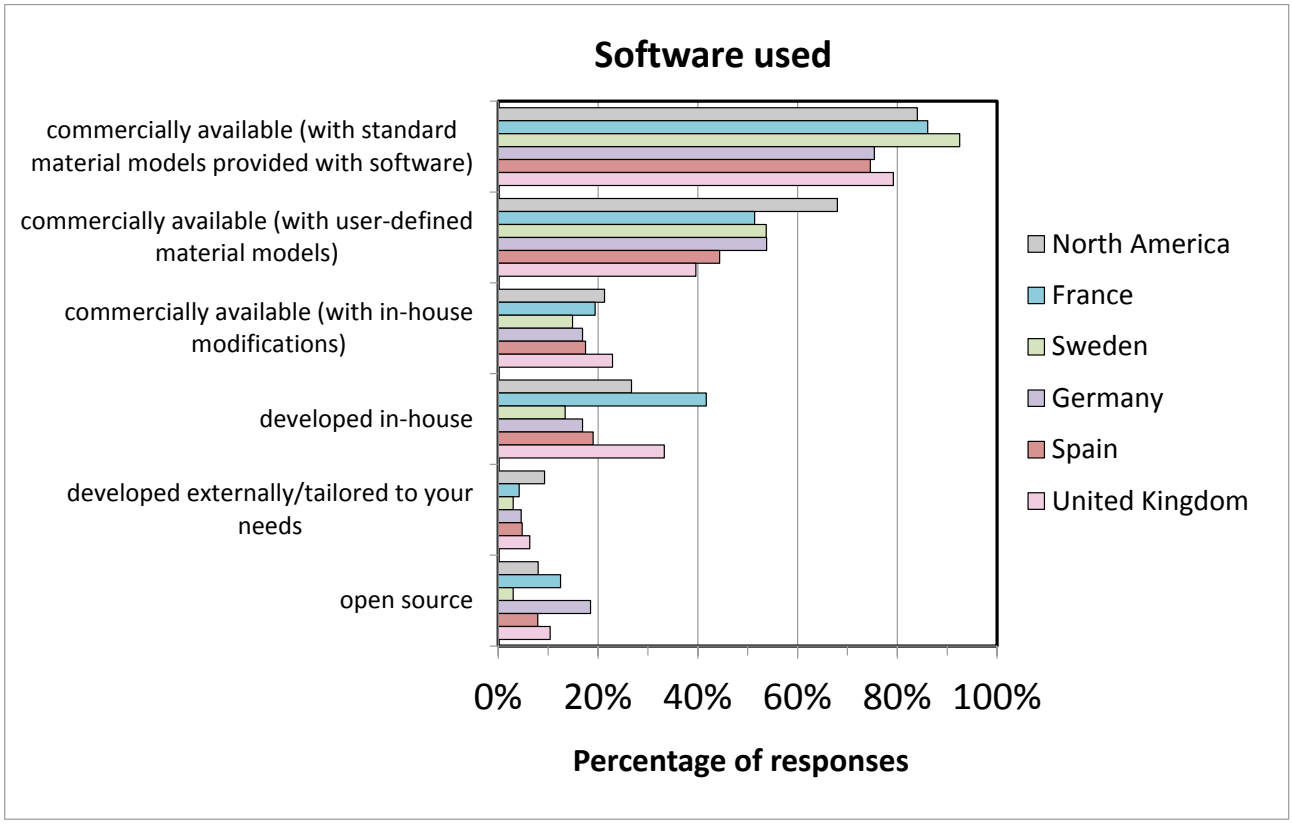

Figure A5. 11- Software used for simulations

Q13. How much of your organisation's time is spent using these different geotechnical numerical methods?

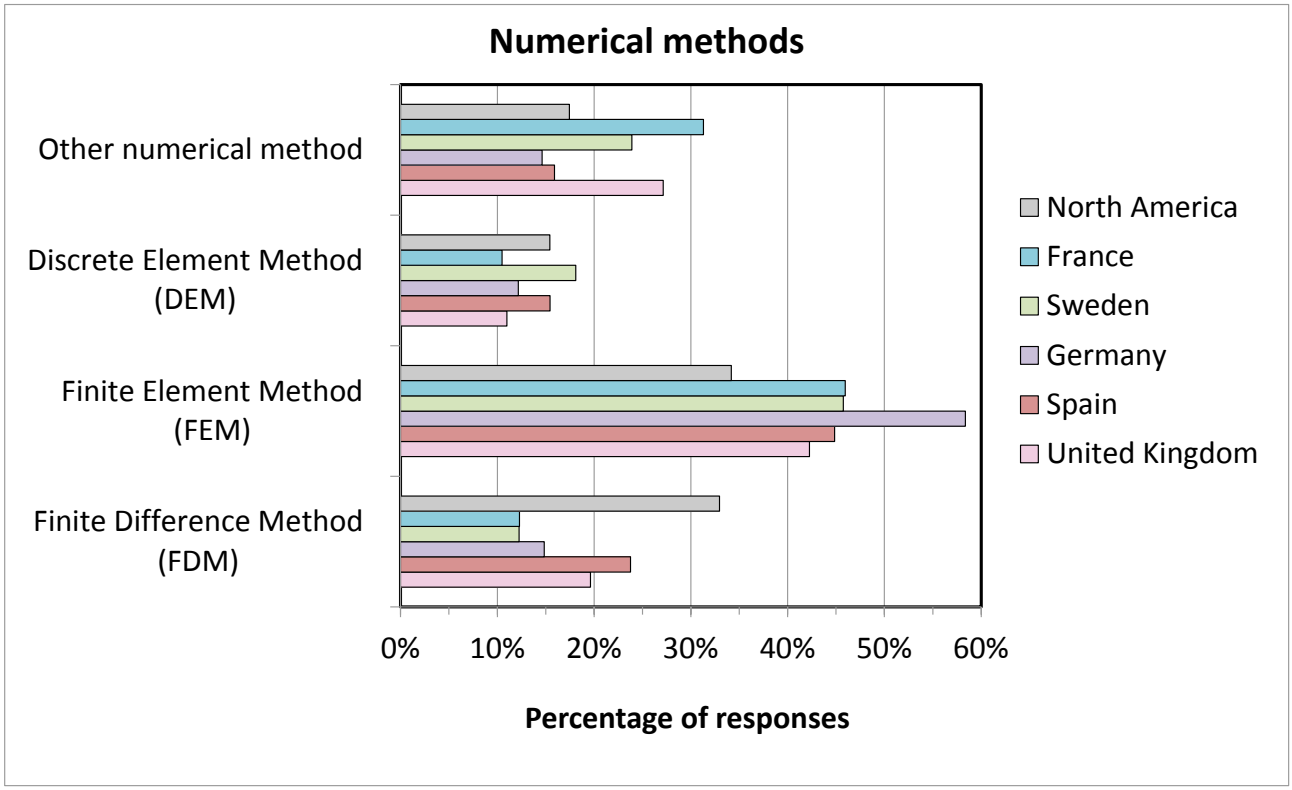

Figure A5. 12- Numerical methods mostly used

Q14. In what field of geotechnical engineering is your organisation working?

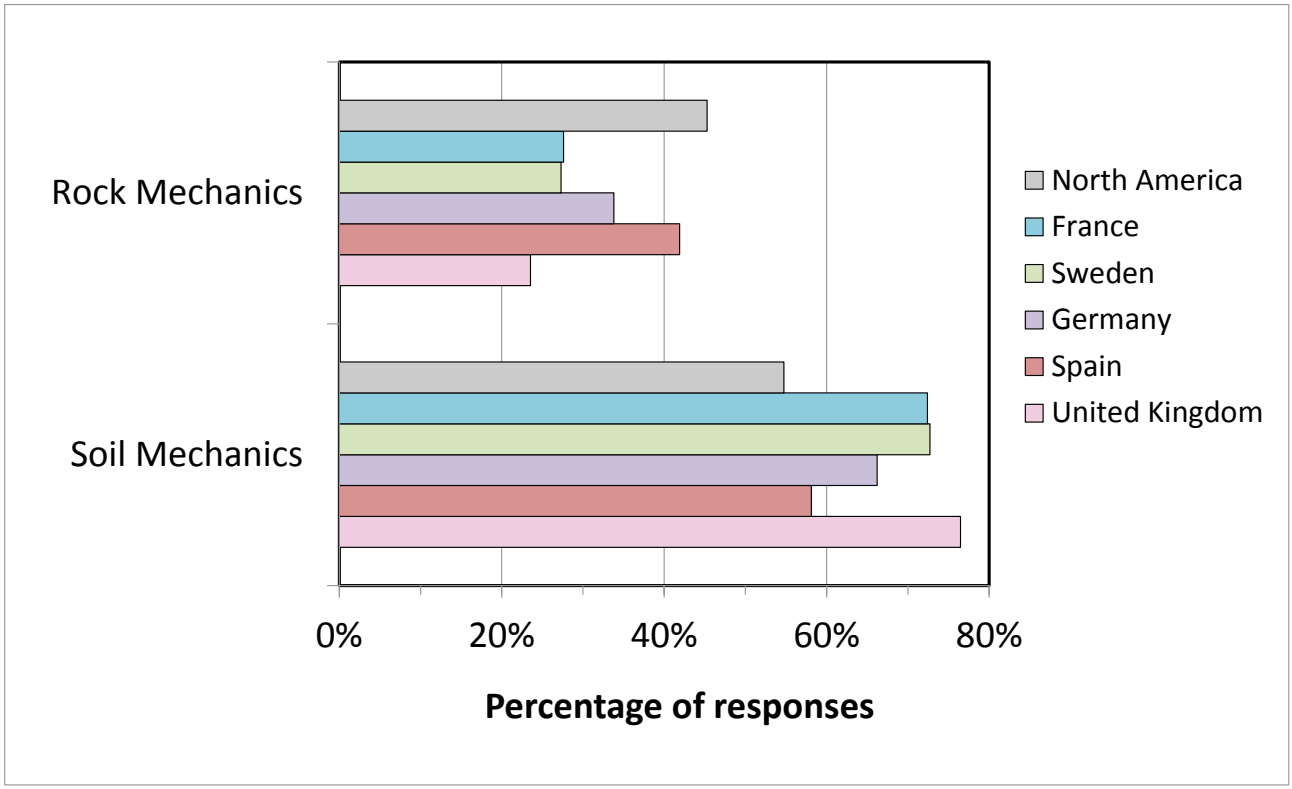

Figure A5. 13- Geotechnical area with which works mostly

Q15. In your opinion, what are the main issues concerning the use of geotechnical numerical analysis software in industry? (where 0=not an issue and 3=serious issue)

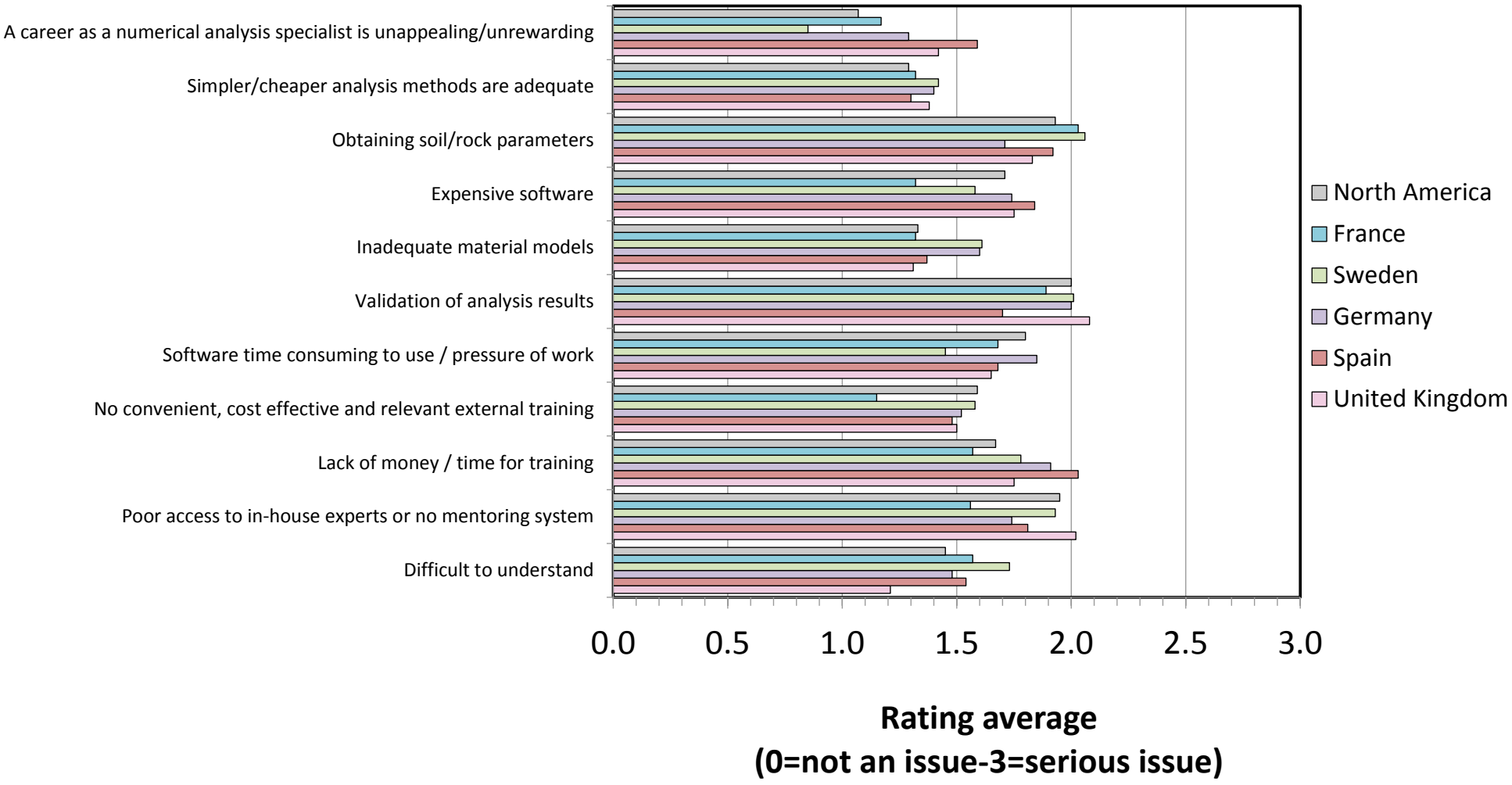

Figure A5. 14 Problems relative with the use of geotechnical numerical software

Q16. In your organisation, are the competences needed to perform different geotechnical numerical analysis tasks formally defined?

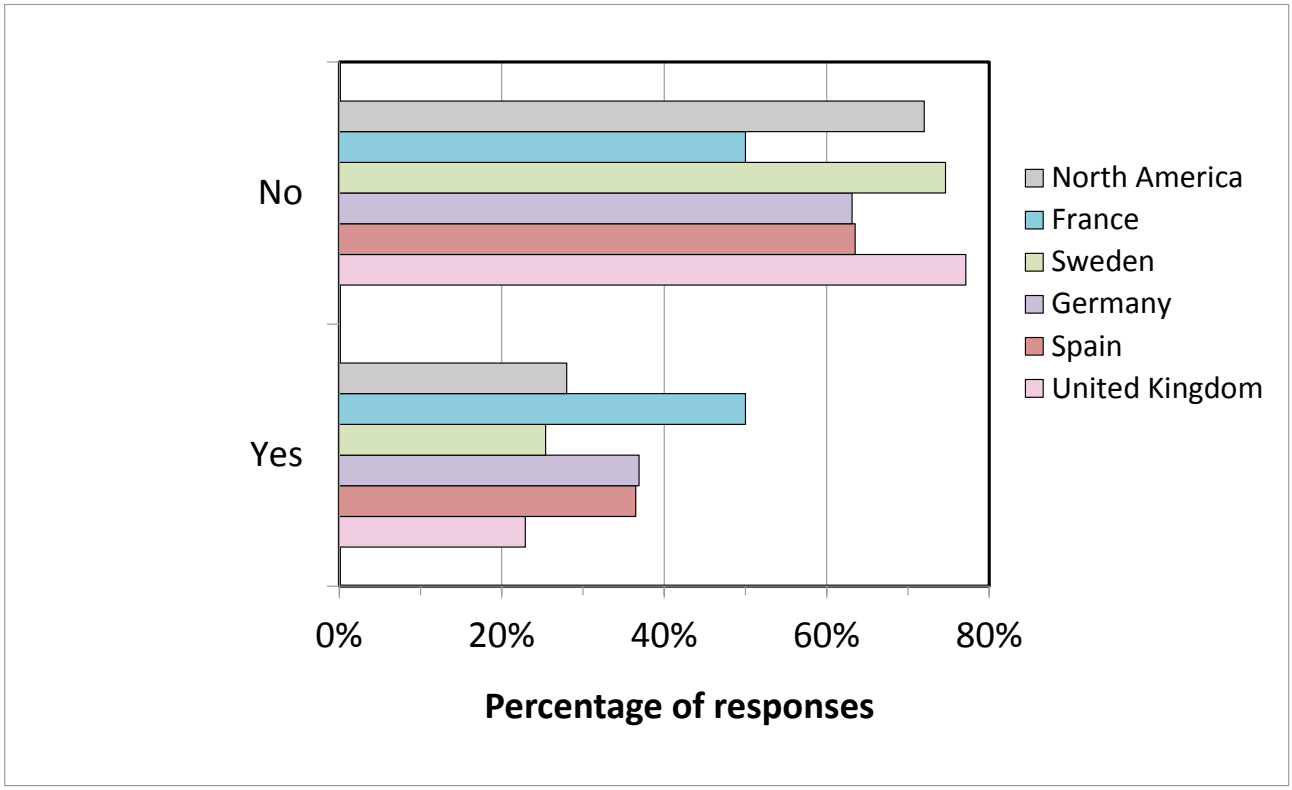

Figure A5. 15 - The competences to use numerical analysis are defined in your organisation?

Q17. In your organisation, is there a system for looking-up and recording staff competences in geotechnical analysis and simulation?

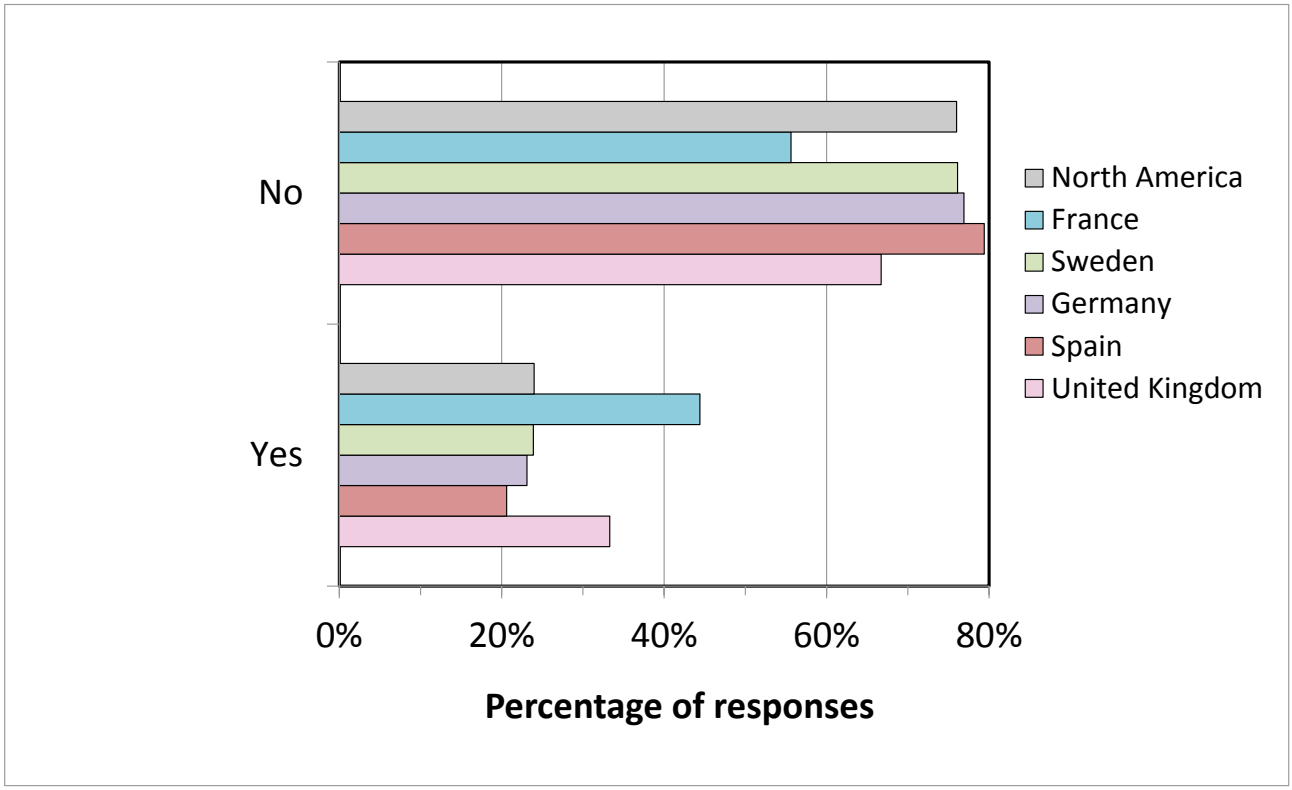

Figure A5. 16 - Does your organisation have a system for looking-up staff competences?

Q18. What medium does your company use to record analyst competences?

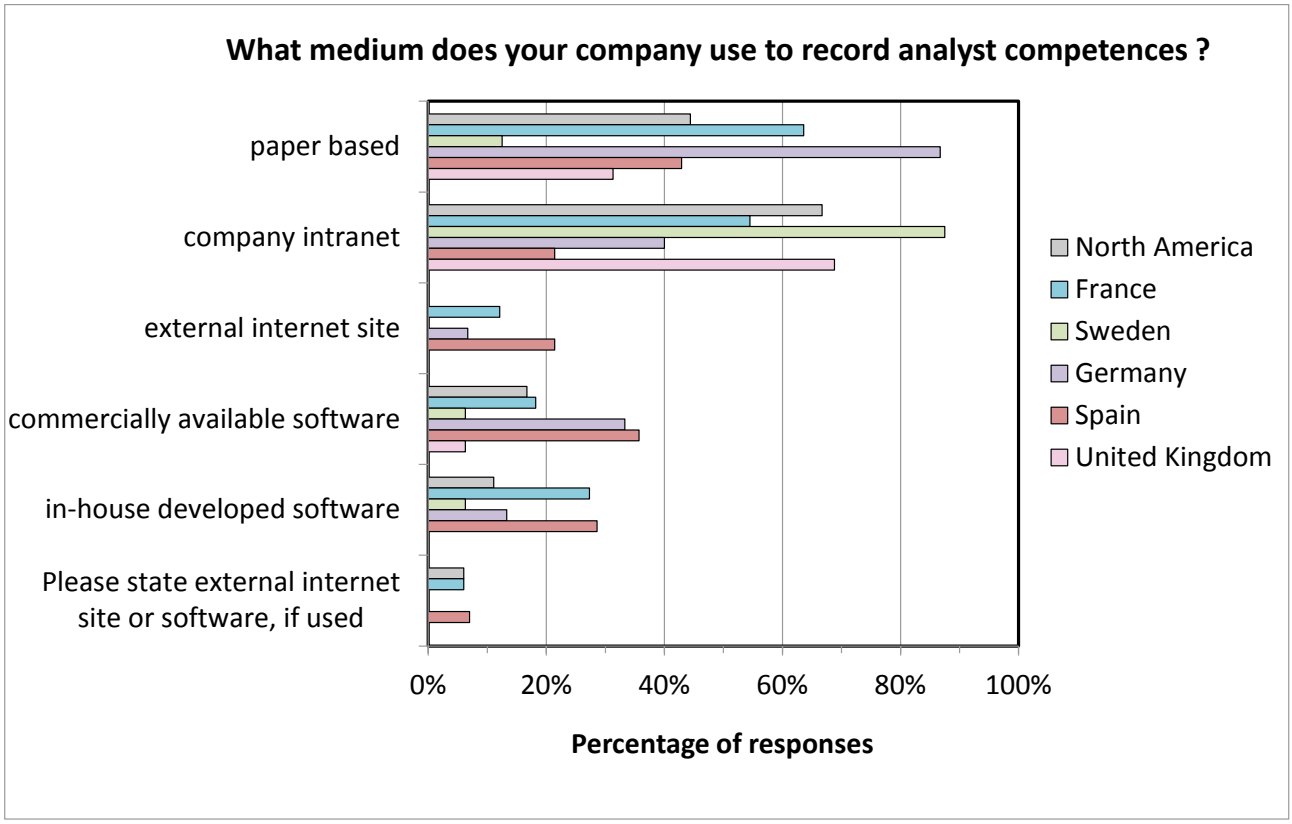

Figure A5. 17 - Medium to record skills of the staff

Q19. How many skill levels (e.g. standard, advanced) are in your existing system for recording analyst competences?

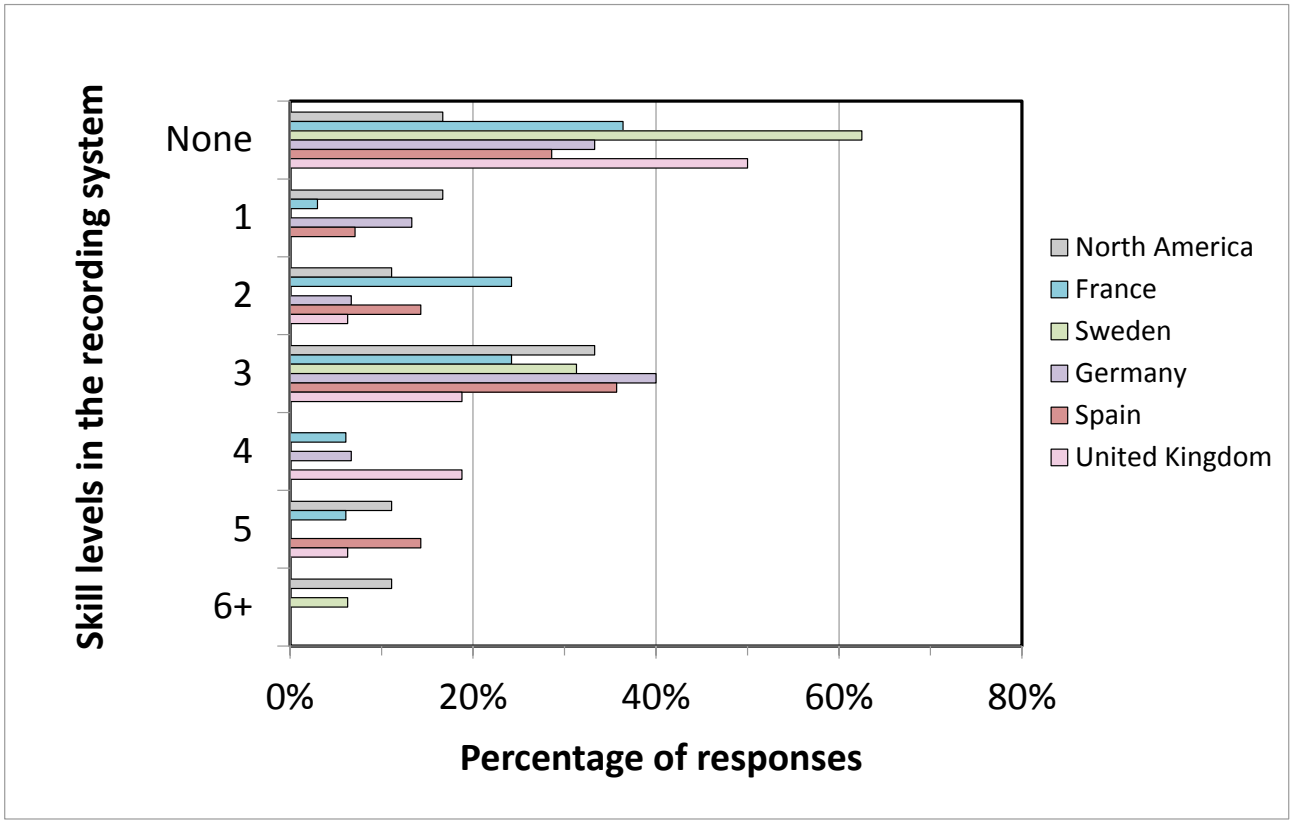

Figure A5. 18 - Number of levels of analyst competences

Q20. How are analyst competences assessed in your organisation?

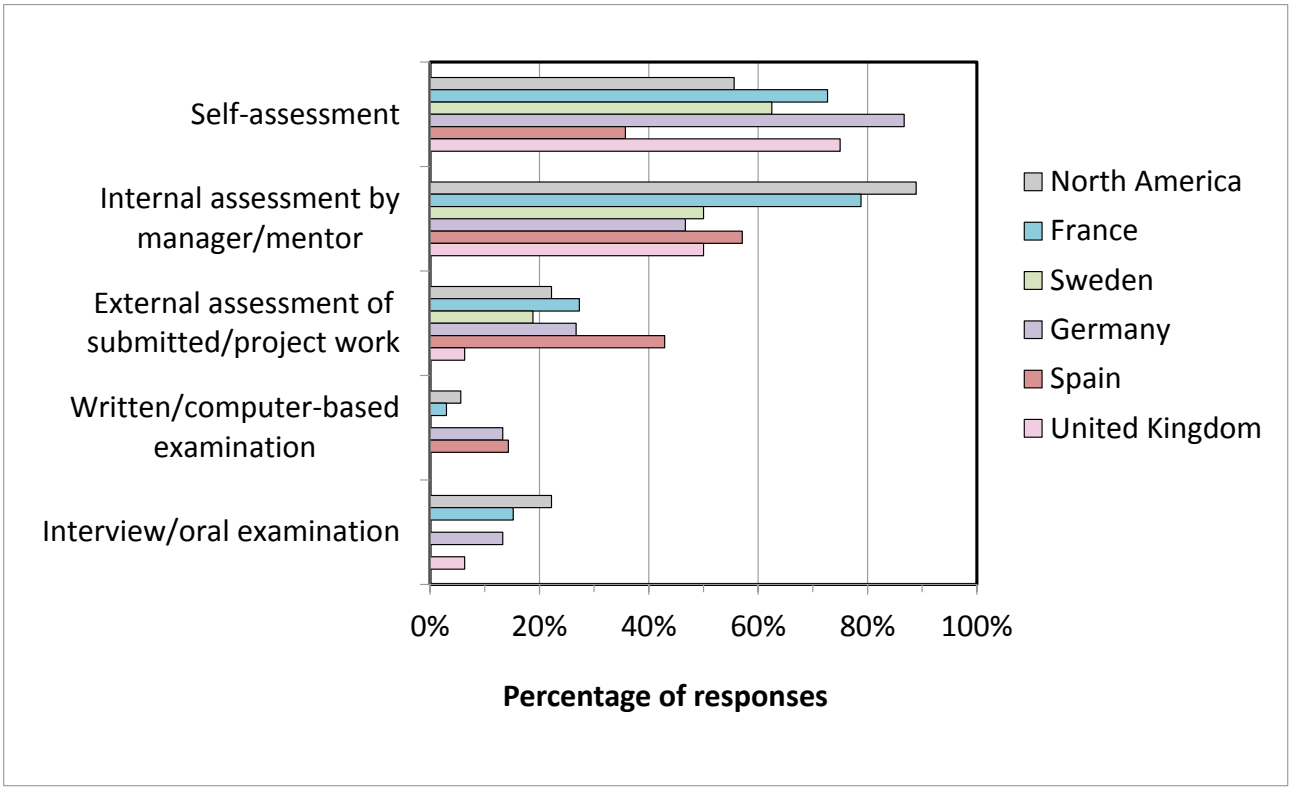

Figure A5. 19 - Analysed competences into each organisation

Q21. Do you think a system that defines competences in geotechnical numerical analysis and provides links to appropriate training resources would be useful for professional development?

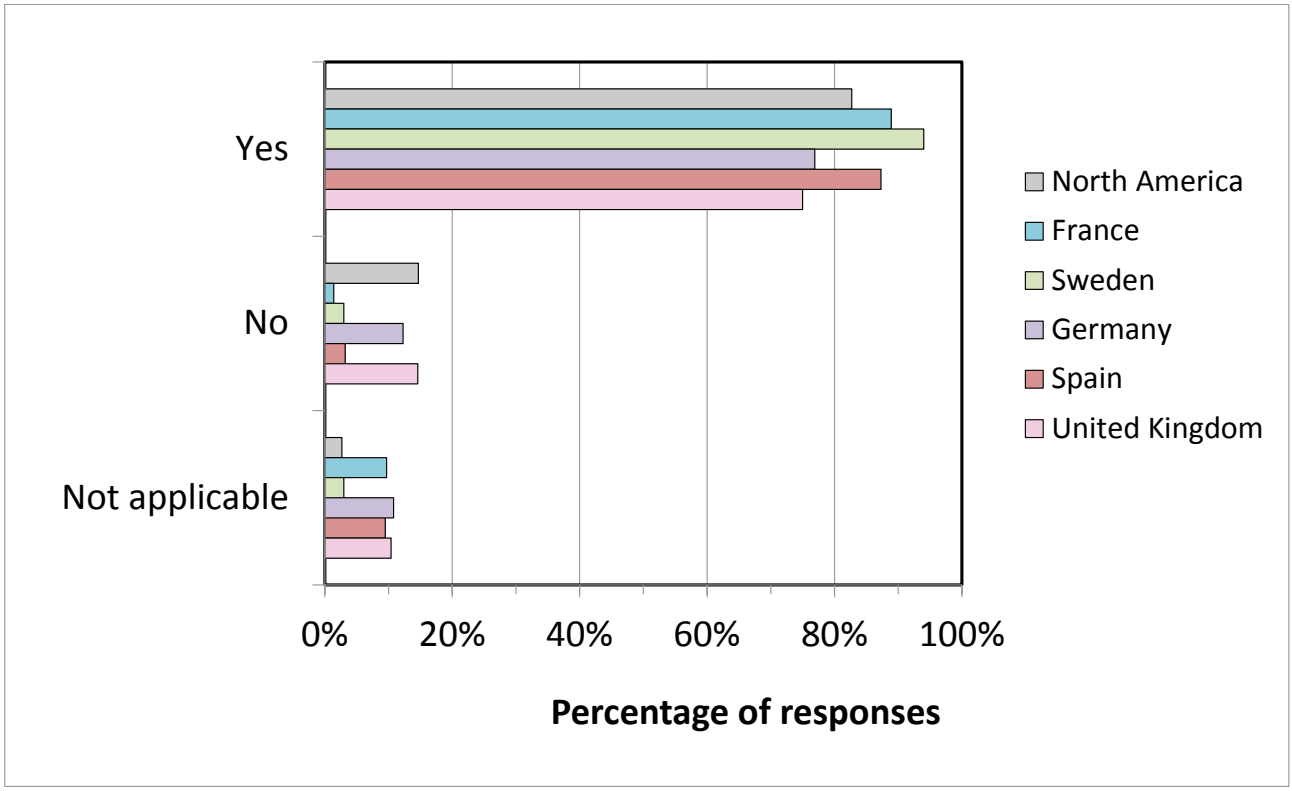

Figure A5. 20 - Useful of knowledge of geotechnical skills and training resources

Q23. How useful do you think the following mediums are for recording analyst competences?

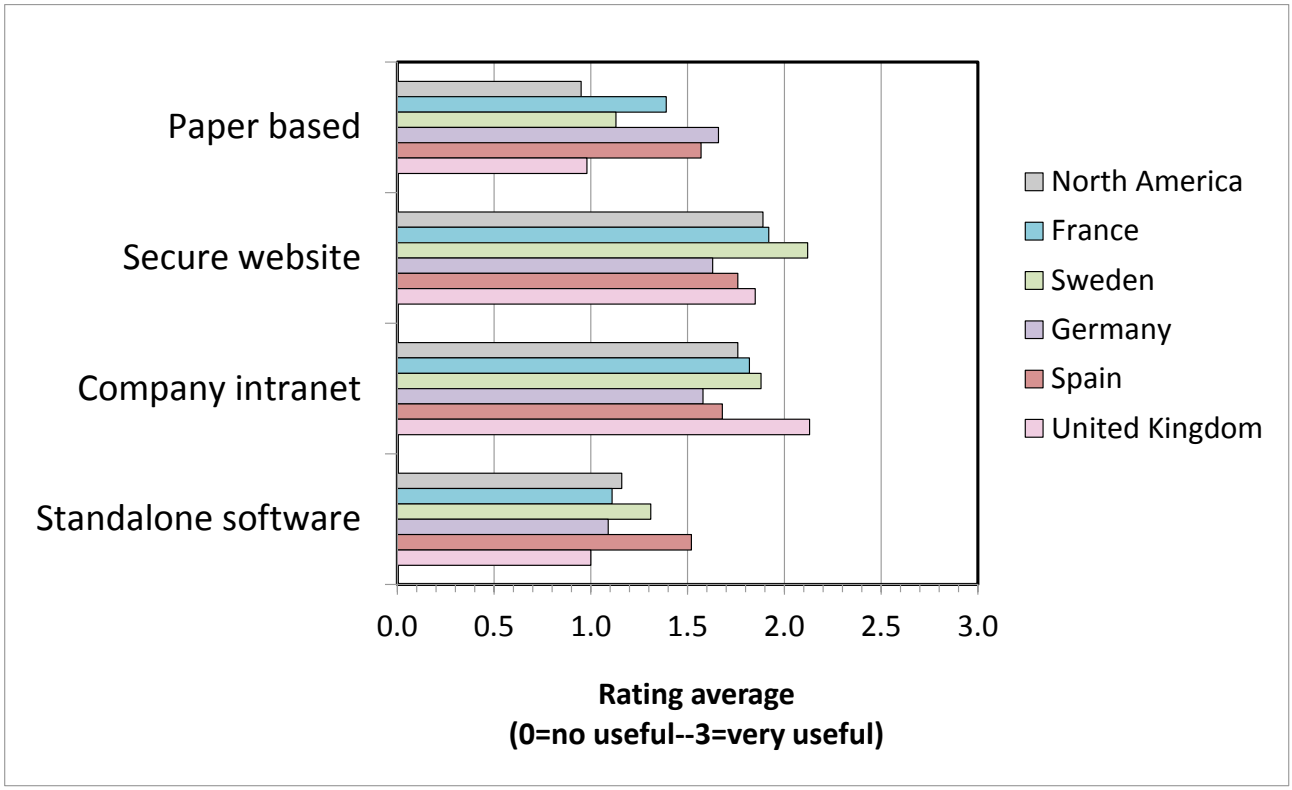

Figure A5. 21 - Useful of recording analyst competences medium

Q24. How many skill levels (e.g. standard, advanced, ...) would be the most appropriate?

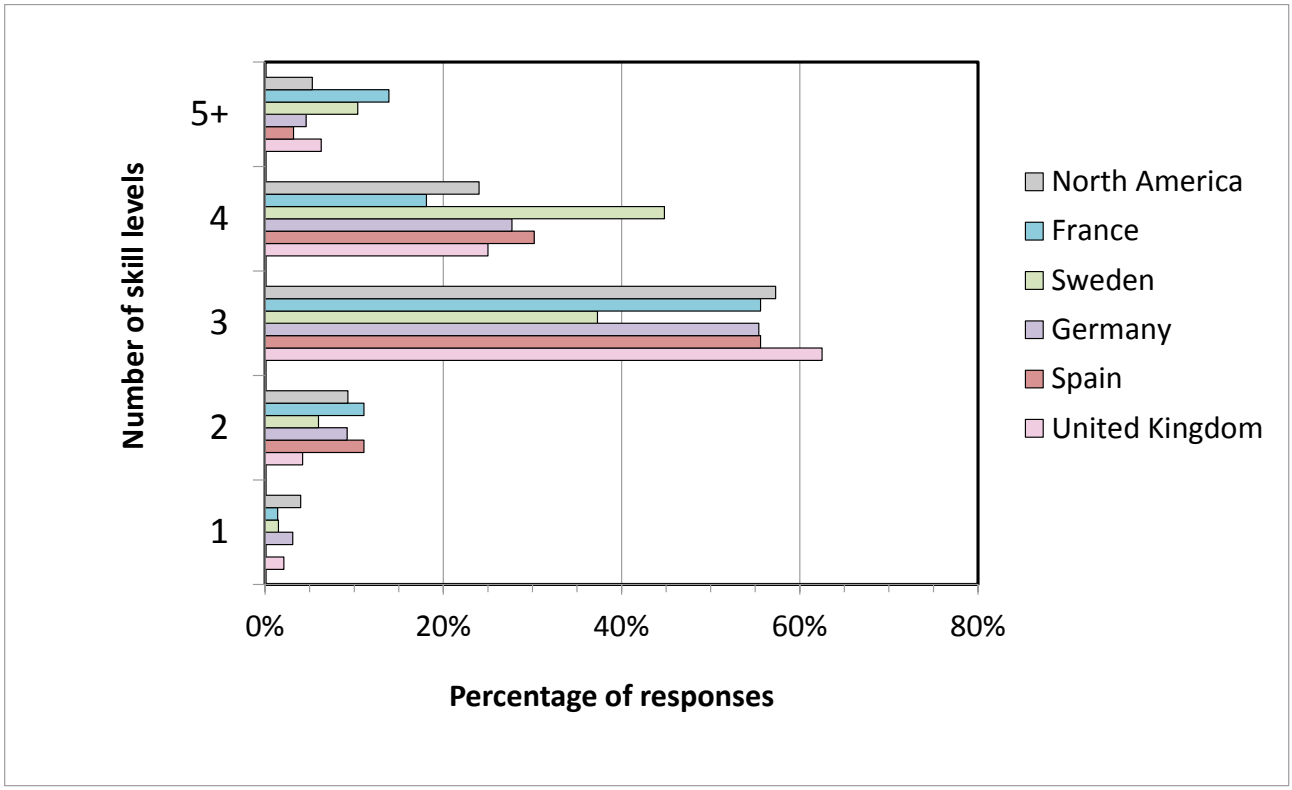

Figure A5. 22 - Number of appropriated skill levels for recoding system

Q25. Which of the areas listed below should be included in a system to define competences in geotechnical numerical analysis?

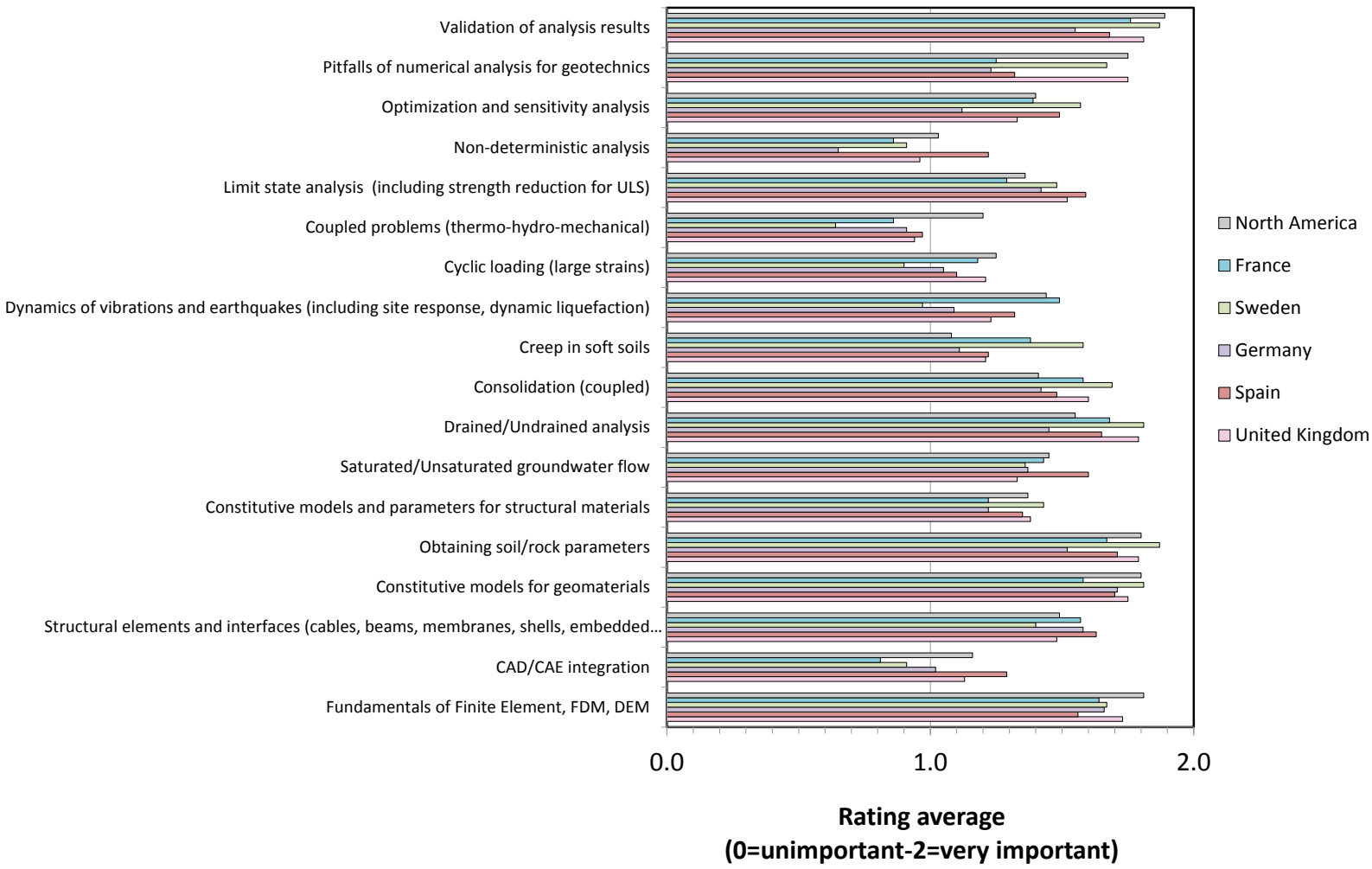

Figure A5. 23 - Geotechnical Knowledge Areas for defining competences

Q26. The competences to be defined covering the areas described above should be focussed in which of the following categories?

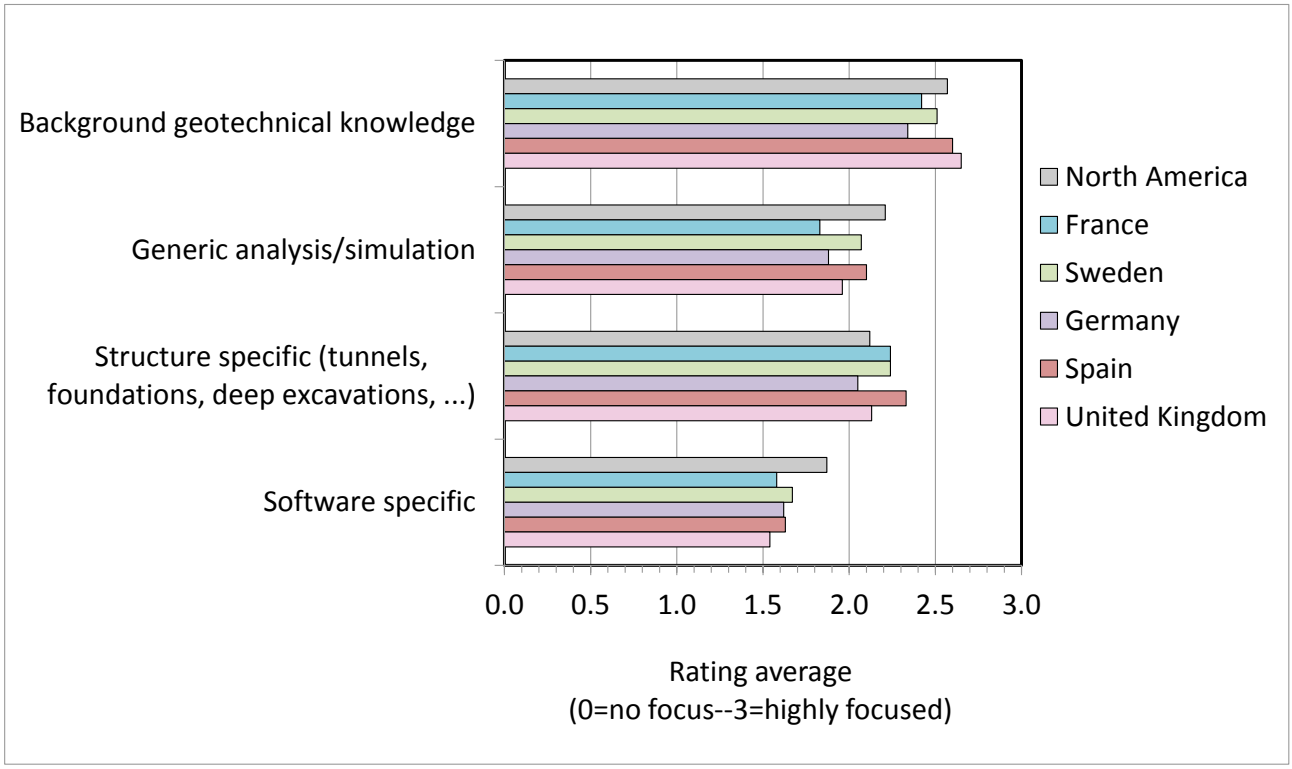

Figure A5. 24 - Geotechnical Knowledge Categories

Q27. From your experience, rate the usefulness of the following learning methods in geotechnical numerical analysis:

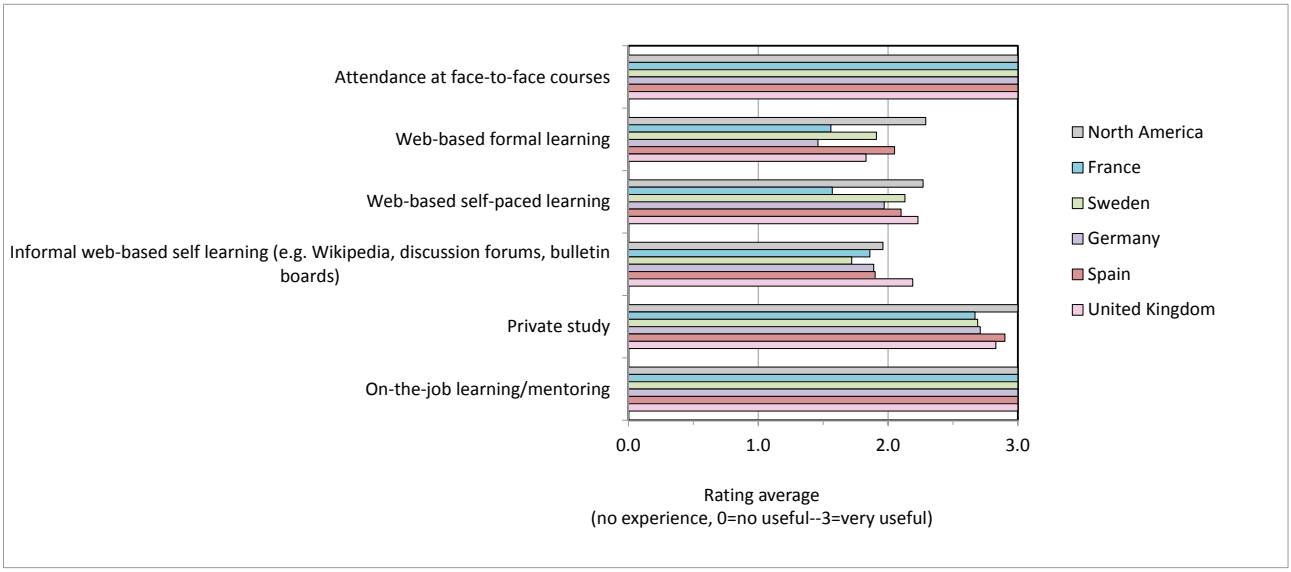

Figure A5. 25 - Learning methods for geotechnical numerical analysis

Q28. In which of the following fields would you like to see the COGAN project develop E-Learning modules next year

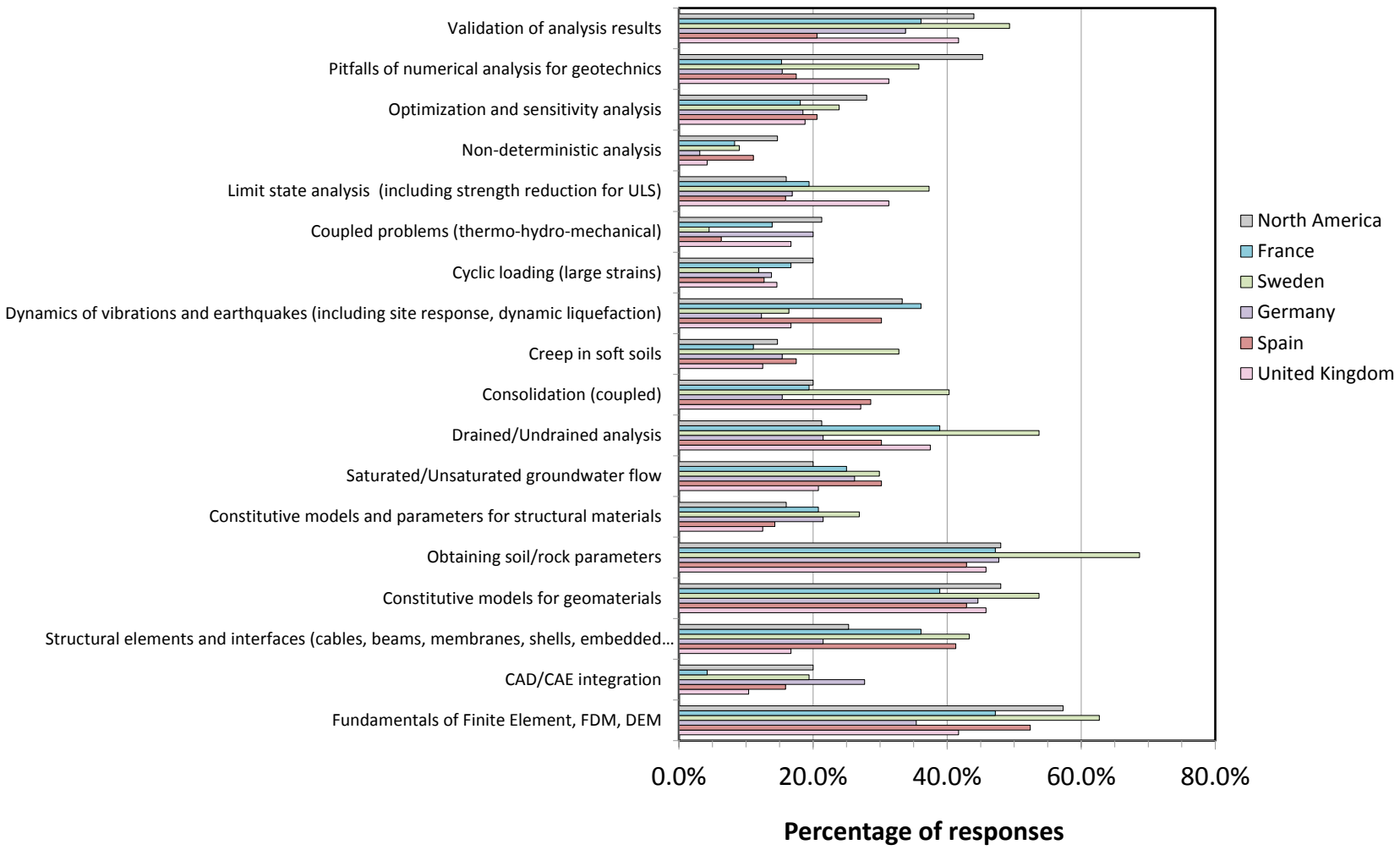

Figure A5. 26 - E-Learning modules

Q29. Would you be willing to evaluate some deliverables of the COGAN project? This might involve a simple road-test of a product or a more technical review

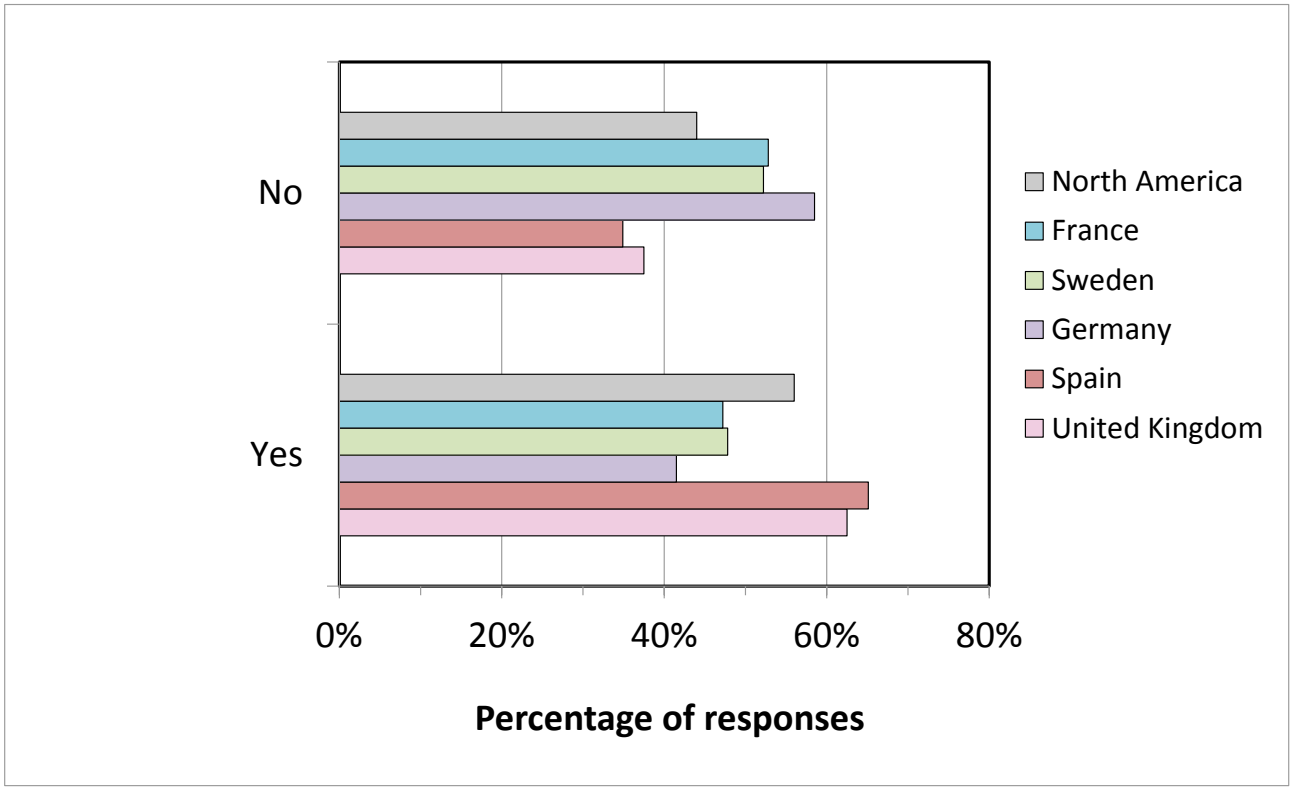

Figure A5. 27 - Percentage of respondents who would like to evaluate some deliverables of COGAN project