**Codes of Practice for Geotechnical Engineering: Site Investigations ( SI ): Review Paper**

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## Abstract

This paper presents a review of some national and regional codes of practice in the area of Geotechnical engineering site investigation (SI). The goal is to identify some significant issues relevant to professional practice in Sudan and to highlight how they were approached and dealt with in different codes.

The scope of the SI comprises the number of points to be investigated. these may be test pits, boreholes, field soundings, geophysical soundings. The extent of the SI is generally described by the depth of boreholes and /or types of field soundings. The scope and extent of SI are strongly related to the types of structures and loadings as well as to the geotechnical character of the site.

The final result of the SI is presented in a geotechnical report, including field work, laboratory work and recommendations for design and construction. The report must be prepared by an experienced Geotechnical Engineer.

The fact that SI is usually carried out in the very early stages of the project, when even the project funding may not have been fully secured, tends to create a situation where costs available for SI may be restricted. It is widely believed that SI is a very significant component of any civil engineering project. While the cost of the SI is a minor component, it is of major importance to project risk management and will positively affect total costs.

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It is recommended that a Sudanese Code of Practice for Geotechnical Engineering be adopted to regulate and upgrade the professional practice in this area. This activity should be carried out under the auspices of the national Standards organization. The Sudanese Society of Soil Mechanics and Geotechnical Engineering can be instrumental in these activities.


**مستخلص**

تعرض هذه الورقة استعراضا لبعض الكودات الوطنية والإقليمية للممارسات في مجال الهندسة الجيوتقنية (دراسة المواقع). الهدف من ذلك هو تحديد بعض القضايا الهامة ذات الصلة بالممارسة المهنية في السودان وتسليط الضوء علىالكيفية التي تم التعامل معها في الكودات المختلفة.

مجال دراسة الموقع يشمل عدد النقاط التي تتم دراستها وهذهقد تكون حفر الاختبار، الآبار، السبر الميداني، السبر الجيوفيزيائي. من ناحية أخرى فإن مدى دراسة الموقع يتم فيه تحديد عمق الآبار أو أنواع السبر الميداني المختلفة. إن مجال ومدى دراسة الموقع يرتبطان بقوة بأنواع المنشآت والحمولات الناتجة عنها فضلا عن الطابع الجيوتقني للموقع.

يتم تقديم النتيجة النهائية لدراسة الموقع في تقرير جيوتقني يشمل تفاصيل العمل الميداني ، والعمل المختبري والتحليل الهندسي بما في ذلك التوصيات اللازمة للتصميم والتشييد. يجب أن يتم إعداد هذا التقرير عن طريق مهندس جيوتقني ذو خبرة كافية.

أن دراسة الموقع عادة مايتم عملها في المراحل المبكرة للمشروع ،حتى عندما يكون تمويل المشروع لم يكتمل ، وفي هذه الحالة تكون هناك ضغوط علىٍ تقليل التكاليف المطلوبة لدراسة وفحص الموقع. وبما أن دراسة الموقع هي عنصرٍ هام جداً في مشاريع الهندسة المدنية. وبما أن تكلفة هذا النشاط تمثل عنصرا صغيراً جداً بالمقارنة بالتكلفة الكلية للمشروع ، وبما أن التجارب المختلفة قد وضحت أن هذا العنصر (دراسة الموقع) له تأثير مباشر على إدارة المخاطر بالمشروع فإنه لابد من التأكيد على أهميةاستكمال دراسة وفحص الموقع بالطريقة المثلى.

يقترح أن يتم اعتماد قانون سوداني لممارسة الهندسة الجيوتقنية لتنظيم وتطوير الممارسة المهنية في هذا المجال.ينبغي أن يتم هذا النشاط تحت إشراف المنظمةالوطنية للمواصفات ويمكن أن تكون الجمعيةالسودانية لميكانيكا التربة والهندسة الجيوتقنية مفيدة في هذا المجال.

## 1. Introduction

### 1.1 Objective

This paper presents a review of some national and regional codes of practice in the area of Geotechnical engineering. The aim of this presentation is to identify some significant issues relevant to professional practice in Sudan and to highlight how they were approached and dealt with in different codes.

Codes from some neighbouring countries i.e. Egypt, Nigeria, Kingdom of Saudi Arabia and Republic of South Africa were considered. Codes from developed countries e.g. ASTM from the USA and BS from the UK as well as the Eurocode from the European Union are also considered. Some of data available in these references, were reproduced for ease of reference.

Geotechnical Engineering issues are somewhat different from those in Structural Engineering due to the nature of Geomaterials , the variabilities in space and the scale of variations in the material properties. As a relatively new field in Civil Engineering, many recent developments have been included specially in the well established International codes.

The final goal is to sensitize the different stake holders, including the professional, academic, regulatory organizations, as well as the general public, about issues which pertain to the national development projects.

### 1.2 Significance of site investigations (SI)

“Without Site Investigation Ground is a Hazard” Littlejohn et al (1994)[1].

The choice of suitable location for a project depends, among other factors, on the geotechnical characterization of site. The design and construction will be based on results of the site investigation. While the cost of soil investigation constitute a very small percentage of the total project cost, the importance of the SI and the risk associated with incomplete knowledge, has repeatedly acknowledged in the literature, e.g. ICE (1991) [2], Goldsworthy et al (2004)[3], Mirza(1998)[4] and Jaksa (2000)[5].

The general requirementsand the technical capability of the SI contractor are usually provided in many codes of practice e.g. SAICE (2010)[6].

The geotechnical study may be carried out in different stages. The simplest is the desk study which is based on available data about the project site such as geological, hydrological and hydrogeological data. Any previous site investigation reports in the same or neighbouring sites will be useful, if available. A walk over of the site is generally recommended.

Following the desk study, planning of a preliminary ground investigation is recommended for the feasibility study of the project. This study may be used in the preliminary design stage. The detailed ground investigation is the last stage of the field work and will be based on plans made, based on the detailed site plan of the project different components. The outcome of this investigation will be used in the detailed design.

The construction phase of the project may require monitoring and/ inspection activities,which may include ground water table,ground deformations and stresses in the soil, if needed. The improvement of subsoil properties may also be checked at different construction stages, if needed.

Inspection of the various construction activities, such as earthworks, concreting, piling activities (either static or dynamic), lowering of groundwater, as well as any other foundation works,should be carried out by competent geotechnical engineers.

The last stage is the maintenance stage which may extend throughout the total life span of the project. Inspection of the substructure and monitoring of instrumentation at the project site, may furnish useful data for the follow up of maintenance and/ or repairs, if needed.

## 2. Phases of sI activities

### 2.1 Planning of site investigations

Types and sizes of different civil engineering project span a wide spectrum. These include big development projects such as airports, dams, roads, high-rise buildings, medium to small size projects such as low to medium rise structures, small to medium rise industrial buildings. Generally, these projects may be categorized as shown in Table(1).

Projects are usually implemented in different phases. These are the feasibility, planning, preliminary design, detailed design, construction and maintenance phases. Some of these phases may be consolidated in one phase or may be dropped altogether. Table(1) integrates the different phases with the project sizes.

**Table(1): Types and sizes of projects**

<table>
<tr><th rowspan="2">Project Phase</th><th rowspan="2">Typical Scale Rquired for Maps</th><th rowspan="2">Boholes per Hectare</th><th rowspan="2">Approximate Spacing (m)</th><th colspan="3">Types of Geotechnical Study for Sizes of Projects</th></tr>
<tr><th>Small Projects</th><th>Medum Proects</th><th>Large Projects</th></tr>
<tr><td>Feasibility Phase</td><td>1: 10,000</td><td>0.1 - 0.2</td><td>200 to 400</td><td rowspan="4">Desktop study/ Site investition</td><td rowspan="2">Desktop study</td><td>Desktop study</td></tr>
<tr><td>Planning Phase</td><td>1: 5,000</td><td>0.5-1.0</td><td>100 to 200</td><td>Definition of needs</td></tr>
<tr><td>Prelimnary engineering Phase</td><td>1: 4,000 to 1: 2,500</td><td>1 - 5</td><td>50 to 100</td><td rowspan="2">Site Invesga-tion (S.I.)</td><td>Preliminary Site Investigation</td></tr>
<tr><td>Detailed design Phase</td><td>1: 2,000 (Roads)</td><td>5 - 10</td><td>30 to 100</td><td>Detailed Site Investigation</td></tr>
<tr><td>Construction Phase</td><td>1: 1,000 (Buildings or Bridges)</td><td>10 - 20</td><td>20 to 30</td><td rowspan="2">Inspection</td><td>Monitor-ing/ Inspec-tion</td><td rowspan="2">Monitoring/ Inspection</td></tr>
<tr><td>Maintenance Phase</td><td></td><td></td><td></td><td>Inspec-tion</td></tr>
</table>

Projects are generally divided into residential and business buildings on one hand and infrastructure and industrial projects on the other hand. Buildings are categorized by size and/or area extent. Infrastructural projects include linear projects such as roads, pipelines, canals, embankments, runways and tunnels. Other infrastructures include dams, culverts etc...Industrial projects include factories, refineries, warehouses etc....

## 2.2 Scope of site investigation

The scope of the SI comprises the number of points to be investigated. these may be test pits, boreholes, field soundings, geophysical soundings. All codes of practice give some indication of extent of SI.

The BS 5930 (1999)[7] for example requires that a minimum of 2 to 3 points are taken for all projects with a minimum spacing for buildings of 20 to 30 m. If some data is already available from the immediate vicinity of the project, then one point may suffice.

The Egyptian code ECP – 202/1 (2001)[8]on the other hand specifies the number of points as one point per 300 square meters of site for buildings. Some reservations and variations are given for small areas and for big residential projects. For pipelines a spacing between 150 to 250 m is recommended between points.

The Eurocode EN 1997-2 (2007)[9] gave indicatory spacing between points for high rise and industrial structures of 15 to 40 m. For large area structures the spacing went up to 60 m. For linear structures such as roads, railways, canals the spacing of 20 to 200 m was given.

### 2.3 Extent of site investigations

The extent of the SI is generally described by the depth of boreholes and /or types of field soundings and their depths. The depth of boreholes and /or soundings are strongly related to the types of structures and loadings as well as to the geotechnical character of the site.

The code of practice for Kingdom of Saudi Arabia SBC: 303 (2007)[10]gave a table showing different needs for building structures including number of points and their depths. Table(2) is presented from that code. The code from Republic of South Africa SAIC (2010)[6]presented the case of shallow and deep foundations. For shallow foundations a depth twice foundation depth is required as a minimum. For deep foundation either 3 times pile diameter is required below pile depth or 0.5 times pile group width below pile depth.

The Eurocode EN 1997-2 (2007)[9]gave details of borehole depths for different types of foundations e.g. shallow, deep as well as retaining structures.

In all codes the engineering judgement of the geotechnical expert is invoked to insure that suitable subsoil layers are reached to achieve reliable needed bearing capacities.

**Table (2): Needs for Different Buildings. (SBC: 303 {2007}[10])**

| No. of Storeys | Built Area ($m^2$) | No. of Boreholes | MinimumDepth for Boreholes Specified | |
|---|---|---|---|---|
| | | | Minimum Depth of Two Thirds of The Boreholes (m) | Minimum Depth of One Third ofTheBoreholes (m) |
| 2 or less | < 600 | 3 | 4 | 6 |
| | 600 - 5000 | 3 - 10 | 5 | 8 |
| | > 5000 | Special investigation | | |
| 3 - 4 | < 600 | 3 | 6 - 8 | 9 - 12 |
| | 600 - 5000 | 3 - 10 | | |
| | > 5000 | Special investigation | | |
| 5 or higher | Special investigation | | | |

Table(3) gives a summary of values for scope of SI for different projects as may be compiled from different codes of practice and presented in Look (2007)[11]

## Table (3): Scope of Different Projects (Look 2007)[11]

| Type of Construction | Test Spacing | Approximate Depth of Soill nvestigations |
|---|---|---|
| Building | 20m to 50m | • (2-4)width for shallow footings (Pads and Strip, respectively)<br>• 3m or 3 pile diameters below the expected founding level for piles. If rock intersected ensure - N*>100 and RQD>25%<br>• 1.5B (building width) for rafts or closely spaced shallow footings<br>• 1.5B below 2/3D (pile depth) for pile rafts |
| Bridges | At each pier location | • 4B-5B for shallow footings<br>• 10 pile diameters in competent strata, or<br>• Consideration of the following if bedrock intersected<br>- 3m minimum rock coring<br>- 3 Pile diameters below target founding level based on<br>▪ N*>150<br>▪ RQD>50%<br>▪ Moderately weathered or better<br>▪ Medium strength or better |
| Embankments | 25m to 50m (critical areas) 100m to 500m as in roads | Beyond base of compressible alluvium at critical loaded/suspect areas, otherwise as in roads. |
| Cut Slopes | 25m to 50m for H>5m<br>50m to 100m for H<5m | 5m below toe of slope or 3m into bedrock below toe whichever is shallower. |
| Landslip | 3 BHs or test pits minimum along critical section | Below slide zone. As a guide (as the slide zone may not be known) use 2×height of slope or width of zone of movement. 5m below toe of slope or 3m into bedrock below toe whichever is shallower. |

## Table (3): Scope of Different Projects (Look 2007)[11] (Continued)

| Type of Construction | Test Spacing | Approximate Depth ofSoilInvestigations |
|---|---|---|
| Pavements/roads | 250m to 500m | 2m below formation level. |
| Local roads<150m | 2 to 3 locations | |
| Local roads>150m | 50m to 100m (3 minimum) | |
| Runways | 250m to 500m | 3m below formation level. |
| Pipelines | 250m to 500m | 1m below invert level. |
| Tunnels | 25m to 50m | 3m below invert level or 1 tunnel diameter, whichever is deeper: greater depths where contiguous piles for retentions. |
| | Deep tunnels need special consideration | Target 0.5-1.5 linear m drilling per route metre of alignment. Lower figure over water or difficult to access urban areas. |
| Dams | 25m to 50m | 2×height of dam, 5m below toe or of slope 3m into bedrock below toe whichever is greater. Extend to zone of low permeability. |
| Canals | 100m to 200m | 3m minimum below invert level or to a zone of low permeability. |
| Culverts | 1 Borehole | 2 B-4 B but below base of compressible layer. |
| <20m width | One at each end | |
| (20-40)m | One at each end and 1 in the middle with maximum spacing of 20m between boreholes | |
| >40m | | |
| Car Parks | 2 Bhs for<50 parks<br>3 Bhs for 50-100<br>4 Bhs for 100-200<br>5 Bhs for 200-400<br>6 Bhs for>400 parks | 2m below formation level. |
| Monopoles & Transmission Towers* | At each location | 0m to 20m high:D=4.5m<br>20m to 30m high:D=6.0m<br>30m to 40m high:D=7.5m<br>40m to 5 0m high:D=9.0m<br>60m to 70m high:D=10.5m<br>70m to 80m high:D=15.0m |

*Applies to medium dense to dense sands and stiff to very stiff clays. Based on assumption on very lightly loaded structure and lateral loads are the main considerations. Reduce D by 20% to 50% if hard clays, very dense sands or competent rock.

Increase D by>30% for loose sands and soft clays.

### 2.4 Ground water

The identification of the existence of ground water at a site is a very important factor in any SI. The effect of pore water pressure has been one of major factors in geotechnical engineering, since the early days of Terzaghi and the effective stress concepts. The seepage issues in different projects as well as stability of slopes need a good understanding of the subsoil ground water regime.

In arid or semi-arid regions where the ground table may be very deep, the effects of changes in the partial saturation of soils should be given due consideration,specially in problematic soils such as expansive and/ or collapsible soils.

## 3.SI Requirements

### 3.1 Professional competence

The SI needs three types of activities to be carried out. These include geotechnical consultancy, Geotechnical field work and laboratory testing. The consultants work gives an overview of the works that can be done by subcontractors. The geotechnical field work includes test pits, excavation and sampling, borehole drilling,testing and sampling and geotechnical and geophysical field testing. if this work is carried out by professional engineers that are licensed to present geotechnical reports, then it is sufficient otherwise the consultant has to provide professional staff forsupervision and reporting. The laboratory testing can also be subcontracted with the same conditions required for fieldwork.

The fact that SI is usually carried out in the very early stages of project inception, when even the project funding may not have been fully secured, tends to create a situation where costs available for SI may be restricted.The procurement procedures of least tender pricing, coupled with high market competition, may lead to tenders been submitted by low capability contractors. A study by Diffin (2004)[12] has shown that in the UK there are still significant shortcomings in the competence and capabilities of ground investigation contractors. It was recommended that uniform quality assurance be carried out for all SI works. It is our belief that, in most developing countries, SI activities are faced with thesame or even more problems.

### 3.2 Geotechnical reporting

The final result of the SI is presented in a geotechnical report, including field work, laboratory work and recommendations for design and construction. The report will depend on the project phase, the needs for feasibility phase is different from those for the preliminary design, or the detailed design phases.

The report must be prepared by a Geotechnical Engineering Consultant with adequate relevant experience.

The submission of the final geotechnical report of the project is needed before the final design is made. The delays may be caused by different factors or individuals. Economic factors may be a major cause. The procurement process may cause delays. The project owner may have to shoulder the major responsibility for such delays or he may have to transfer such responsibility to the project consultant.

The BS 5930:1999[7] recommends that construction issues be addressed such as temporary works, excavation and excavation supports where needed, soil improvement, ground water, soil contamination and such issues.

The SAIC code 2010[6] recommends that issues of problematic soils in South Africa such as expansive and collapsible soils as well as dolomitic formation should be addressed in the report if relevant.

The geotechnical report should include all necessary items to help the project designer in his work. The Eurocode,EN 1997-2:2007[9], states the report shall be composed of two parts:

**1.** Factual report about ground investigation, soil sampling, field and laboratory testing. Other relevant data shall also be included.

**2.** Interpretation of data and recommendations for design shall be given in detail showing methods of implementation and calculations when requested.

### 3.3 SI Costs

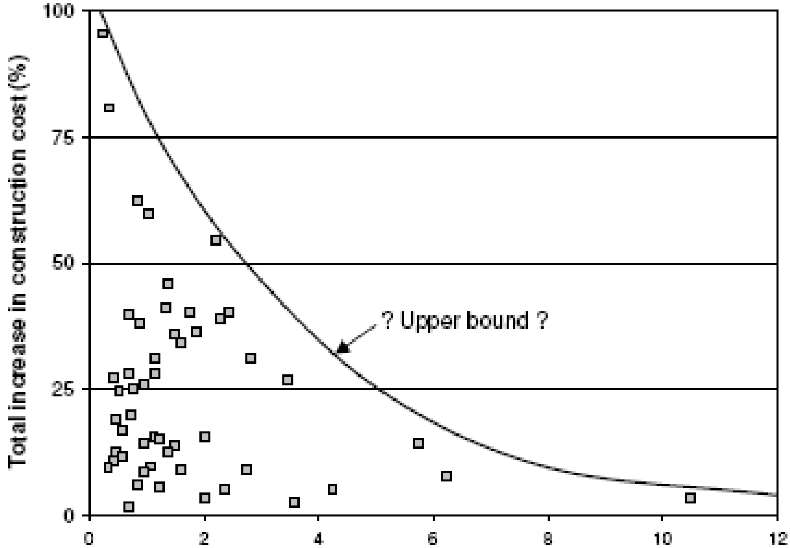
"You pay for a site investigation whether you have one or not" (ICE 1991)[2].

Rowe (1972)[13] presented a summary of the cost of SIs for different types of projects as a percentage of total project cost as well as earthworks and foundation cost. This is given in Table(4).

**Table(4): Cost of Different Project Types ( Rowe 1972)[13]**

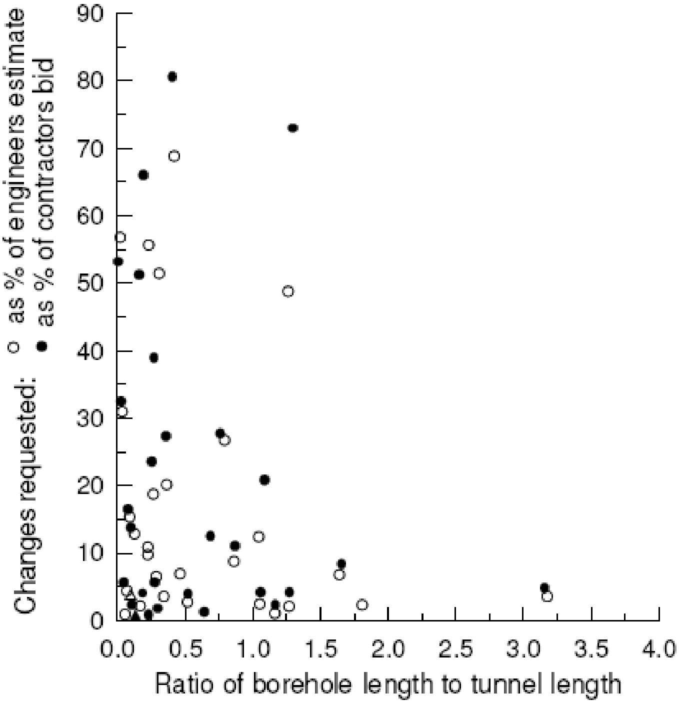
| Type of Work | % of capital cost of works | % of earthworks and foundation costs |
|---|---|---|
| Earth dams | 0.9 - 3.3 | 1.1 - 5.2 |
| Embankments | 0.1 - 0.2 | 0.2 |
| Docks | 0.2 - 0.5 | 0.4 - 1.7 |
| Bridges | 0.1 - 0.5 | 0.3 - 1.3 |
| Buildings | 0.1 - 0.2 | 0.50- 2.0 |
| Roads | 0.2 - 1.6 | 1.6 - 5.7 |
| Railways | 0.6 - 2.0 | 3.5 |
| Overall mean | 0.7 | 1.5 |

A survey of actual cost overruns in highway projects in the UK in the eighties of last century was carried out by Mott Mac Donald (1994)[14]. Fig(1) shows the relationship between cost overruns and the relative cost of SIs.




**Fig(1): Cost Over-run of Highway Projects (Mott MacDonald 1994) [14].**

Hoek and Palmeiri (1998)[15] presented the case for long tunnels where the cost overruns are related to ratio of borehole length to tunnel length as shown in Fig(2).




**Fig(2): Cost Over-run for Tunnel Projects(Hoek and Palmeiri (1998)[15]).**

Chapman (2008)[16] studied the issue of delays in construction time for high rise development buildings in the UK. It was found that 50% of the buildings projects are delayed by at least one month. Of these projects 40% of causes are related to SI stage. based on the simplified assumption of a delay of one month of a project that is financed by a commercial bank and that the cost overrun is due only to bank dues, then Chapman[16] found that the saving made in reducing SI cost will most probably cause a financial loss to the building developer of more than ten times the expected saving.

## 4. Discussion and conclusion

### 4.1 Discussion

The above presentation shows that SI is a very significant component of any civil engineering project. While the cost of the SI is a minor component, it is of major importance to risk management and will positively affect project costs.

Recent studies in risk management and its applications in Geotechnical Engineering has included risk studies in Site Investigations. The risks in geotechnical engineering are intrinsic to the uncertainties associated with geomaterials and their behaviour. For SI the risks are associated with incomplete investigations. To reduce such risks extent and scope of SI must be carefully planned. Supervision of the construction stage should be done by a competent geotechnical engineer soas to identify any discrepancy in actual field conditions. Such differences between SI findings on a limited number of boreholes or test pits and the actual conditions in the ground is not unexpected. Hence such incidents should not be overlooked or kept secret but should be addressed and considered in design review.

The codes of practice for the African middle east countries reflect the developing nature of these countries where detailed code requirements have to be specified.

For the BS and ASTM the details are sometimes left out as the state of the art of the profession has already been accepted. TheEurocode on the other hand is a new standard that has been accepted for all EU countries and is being introduced for implementation in the individual countries starting in 2010. The details given there are due to harmonization of codes of practice in individual countries.

The details of the field work and laboratory work as part of the SI has been given in detail in the different codes. These topics are not discussed here as they are generally covered in academic programs in civil engineering in a reasonably accepted level.

### 4.2 Conclusions

It is highly recommended that a Sudanese Code of Practice for Geotechnical Engineering be adopted to upgrade the professional practice in this area. This activity should be carried out under the auspices of the national Standards organization. The Sudanese Society of Soil Mechanics and Geotechnical Engineering can be instrumental in these activities.

## 5. References


[1] Littlejohn G. S , Cole K. W and Mellor T. W " Without Site Investigation Ground is a Hazard" Proc. Instit. CivilEngrs, Civil Engineering, 1994, vol. 102.

[2] ICE , "Inadequate Site Investigation", The Institute of Civil Engineers, Thomas Telford ,1991.

[3] Goldsworthy G. S., Jaksa M. B., Kaggwa W. S., Fenton G. A., Griffiths D. A., Poulos H. G. "Cost of foundation failures due to limited site investigations" , Intl. Conf. on Structural and Foundation Failures, Singapore, 2004.

[4] Mirza C. "The high cost of low bid cost site characterisation", Geotechnical Site Characterisation, Robertson and Mayne (eds) ,Balkema, Rotterdam, 1998.

[5] Jaksa M. B. "Geotechnical risk and inadequate site investigation: a case study", Australian Geomechanics, 2000, vol. 35.

[6] SAICE "Site Investigation Code of Practice" , South

African Institution of Civil Engineers: Geotechnical Division , 2010.

[7] BS 5930: 1999, "Code of Practice for Site Investigation" , British Standard Institute, 1999.

[8] ECP - 202/1 - 2001 "Egyptian Code for Soil Mechanics and Foundation Design and Construction", Cairo, 2007.

[9] EN 1997-2:2007 "Euorocode 7 - Geotechnical Design- Part 2: Ground Investigation and Testing" European Committee for Standardisation Brussels, 2007.

[10] SBC: 303 "Saudi Building Code Requirement: 303 - Structural - Soil and Foundations ", Saudi Building Code National Code , 2007.

[11] Look B. G. "Handbook of geotechnical Investigations and Design tables", Taylor and Francis, London, 2007.

[12] DiffinBT "procurement and quality of site investigation in the U K " M Eng. dissertation . university of Surrey, Department of Civil Engineering, 2004.

[13] Rowe P. W. "The relevance of soil fabric to soil investigation practice" geotechnique , 1972, 12.

[14] Mott MacDonald and Soil Mechanics Ltd "Study of the efficiency of site investigation practice", Project report 60, E063A/HG, TRRL , Berkshire, 1994.

[15] Hoek E. and Palmieri A. "Geotechnical risks on large civil engineering projects", Intl. Assoc. of Engineering Geologists Congress, Vancouver, Canada, 1998.

[16] Chapman T. J. P. "The relevance of development costs in geotechnical risk management", the proc. of second intl. BGA conf. on foundations, Brown M. J. et al (eds) 1998.

إن دكتور عبدالله أحد الأعضاء المؤسسين والمشاركين لمكتب الإستشارات الخاص فى الهندسة والتخطيط والعمارة، منذ ١٩٨٢.

وأما فيما يتعلق بالدكتور عبدالله الباحث والمحاضر فقد كان تخصصه الرئيس هو الهندسة الإنشائية، على حين كان تخصصه الدقيق هو تصميم وتكنولوجيا الخرسانة وتصميم الحديد.

وقد تمخض عن أبحاثه التى أجراها وعن خبرته الطويلة أنه شارك فى العديد من ورش العمل والمؤتمرات والسمنارات، وأشرف على العديد من مشاريع وبحوث التخرج وعلى العديد من الدراسات فوق الجامعية المفضية إلى منح درجة الماجستير.

وقد امتدت مشاركاتُه لتشمل:

- تقييم الوضع الراهن لبعض المبانى (لتحديد المشاكل ووضع الحلول)، مثل مبنى فندق الهلتون
- تقييم بعض المشروعات على المستوى القومى والوطنى، مثل مجمع مصنع النسيج السودانى
- المشاركة فى اللجان الفنية، فقد عمل مثلاً عضواً بلجنة مواد الإنشاء للهيئه السودانية للمواصفات والمقاييس، وعضواً بمجلس الجمعية الهندسية، كما عمل عضواً بمجلس إدارة مصنع أسمنت عطبرة، وعمل عضواً فى غير ذلك مما ذكرنا

لم يكن فَقدُ الدكتور عبدالله إبراهيم خسارةً عظيمةً للمعهد ولزملائه حسب بل كان كذلك خسارةً كبيرةً لعدد كبير من المؤسسات والجامعات وخسارةً لوطنه.

**وختاماً ندعو الله ضارعين أن يتقبله عنده من الصالحين وأن يسعد روحه فى الأرواح**

بسم الله الرحمن الرحيم

**وَلَنَبْلُوَنَّكُمْ بِشَيْءٍ مِنَ الْخَوْفِ وَالْجُوعِ وَنَقْصٍ مِنَ الأَمْوَالِ وَالأَنْفُسِ وَالثَّمَرَاتِ وَبَشِّرِ الصَّابِرِينَ (١٥٥) (سورة البقرة)**

ينعى معهد بحوث البناء والطرق بجامعة الخرطوم ببالغ الحزن والأسى المرحوم د. عبدالله إبراهيم فضل، الذى رحل عن دنيانا فى يوم الجمعة ٢٨ فبراير ٢٠١٤ مُسلماً الروح إلى بارئها.

لقد كان الدكتور عبدالله أحد أعمدة المعهد بعد أن التحق بسلك التدريس بالجامعة منذ تخرجه فى عام ١٩٦٣ بدرجة بكالوريوس العلوم، مرتبة الشرف الأولى فى الهندسة المدنية، بكلية الهندسة والعمارة بجامعة الخرطوم. ولقد حافظ على مستواه العالى هذا خلال تلقيه لدراساته فوق الجامعية، فنال درجة الدبلوم فى تكنولوجيا الخرسانة من كلية إمبريال بجامعة لندن فى العام ١٩٦٤، ونال درجة الدكتوراه فى الهندسة المدنية من جامعة إلينوي بالولايات المتحدة الأمريكية فى ١٩٧٦ .

ونظراً لكل هذه المؤهلات العالية التى كان يتحلى بها فقد عُيّن مساعد تدريس ثم باحثاً بمعهد بحوث البناء والطرق، ومن ثَمّ رئيساً لقسم مواد البناء والإنشاء فى الفترة من ١٩٧٦ إلى ١٩٧٨، ثم صار مديراً للمعهد فى الفترة من ١٩٧٨ إلى ١٩٨٠.

وبعد انتدابه إلى جامعة الكويت عاد أستاذاً مشاركاً بكلية الهندسة بجامعة الخرطوم. فقد تم تعيينه فيها رئيساً لقسم الهندسة المدنية بكلية الهندسة للفترة من ١٩٨٥ إلى ١٩٨٧، ثم عميداً لكلية الهندسة للفترة من ١٩٩١ إلى ١٩٩٣. وفى العام ٢٠٠٠ رجع دكتور عبدالله إلى المعهد أستاذاً وظلّ به حتى تقاعد بالمعاش فى العام ٢٠١٠ .

وفيما يتعلق بتأهيله المهنى فقد كان الدكتور عبدالله زميلاً بالجمعية الهندسية ومهندساً مستشاراً بالمجلس الهندسى السودانى.

# رســالة من المحــرر

احتفل معهد بحوث البناء والطرق بجامعة الخرطوم بيوبيله الذهبى (١٩٦٣- ٢٠١٤) وذلك فى الفترة من ٢٠ الى ٢٢ أبريل ٢٠١٤ . وقد وقف المعهد فى هذه المناسبة على دوره استعرض رسالته ووقف مقيماً كم من أهدافه قد تمكن من تحقيقها . وقد ظهرذلك جلياً فى برنامج يوبيله الذهبى . فبجانب الجلسة الافتتاحية اشتمل برنامج اليوبيل على سبع جلسات ، عالجت كل جلسة منها مجالاً من مجالات نشاط المعهد . وقد صاحب اليوبيل مَعرضٌ بيّن وعكس مختلف مجالات النشاط الذى يزاوله المعهد والتى تشمل البحوث والخدمات الفنية (المعمل والاختبار والفحص ومشروعات الخدمات ) وخدمات التدريب ( فى مجال الدراسات الجامعية والدراسات فوق الجامعية وللمهندسين والفنيين ) . كما اشتمل المعرض على مطبقات إعلامية وملصقات تظهر أسماء العاملين بالمعهد وأقسامه وأهدافه

**وقد كانت موضوعات الجلسات على النحو التالى :**

**الجلسة الأولى** : واقع السياسات والتنفيذ فى الإسكان الحضرى
**الجلسة الثانية** : الأداء فى المبانى ومواد البناء فى السودان
**الجلسة الثالثة** : مواد الطرق وتصميمها فى السودان
**الجلسة الرابعة** : مستقبل الهندسة الجيوتقنية فى السودان
**الجلسة الخامسة** : معايير وقوانين الممارسة فى المبانى والطرق
**الجلسة السادسة** : أداء الطرق وسلامة حركة المرور
**الجلسة السابعة** : تقييم الأداء الماضى والحاضر للمعهد ، ومستقبل رؤاه

وفى اليوم الأخير من أيام الاحتفال ، كرّم المعهد سبعة عشر من عامليه الذين تقاعدوا بالمعاش ، والذين كانت لهم مساهمتهم البارزة والمؤثرة فى تقدم المعهد .

وبهذه المناسبة ، نذكر أن مجلة بحوث المبانى والطرق تلعب دوراً عظيماً فى توثيق نتائج الأبحاث التى يجربها معهد بحوث البناء والطرق ، وتنشرِ المعرفة فى الحقل المتعلق بوظيفة المعهد وإلى هذا اليوم بلغت إصدارات المجلة ١٥ مجلداً منذ تأسيسها فى ١٩٩٧ ونشرت أكثر من ٧٥ ورقة علمية محكّمة . وليس من سبيل إلى استمرارية هذه المجلة فى الصدور إلا برَفدها بالمادة الفنية الجيدة المتعلقة بمجالها ، ولهذا ندعو المهندسين والمعماريين وغيرهم الذين يعملون فى مختلف المجالات المتعلقة بتخصص هذه المجلة إلى أن يمدوها بالمادة العلمية الصالحة للنشر.