# Study On The Optimum Cement Deep Mixing Columns Configuration By Simplified Design Method

**Nguyen Ngoc Thang**
Tien Giang University, Vietnam.
E-mail: nguyenngocthang@tgu.edu.vn

**Dinh Tran Ngoc Huy**
MBA, Banking University
HCMC, Ho Chi Minh City,
Vietnam. International University
of Japan, Japan.
E-mail: dtnhuy2010@gmail.com

---

## Abstract

During the course of the development over the past few decades, at various stages, well documented stage of the art reports dealing with the techniques of improving ground conditions, design methodology, and specific records of adopting different methods. Among these methods, Cement Deep Mixing (CDM) columns formed by DMM is an economical and effective methods to treat the soft soils under embankment. In this research the configuration of the CDM column, which is embedded in the soft ground layers, is investigated for different sizes of diameter, spacing and length of CDM column. By this research, a new method to find out the optimum configuration using the formula in the current design is proposed as the Simplified Design Method.

The soil improvement technique, called Deep Mixing Method (DMM), is often applied for improve the strength of the treated soft ground in Delta areas. In recent years design and construction of infrastructure facilities arising due to extensive urbanization and industrialization in soft clay zones has considerably increased.

## Keywords

Soft Ground, Mekong Delta, Deep Mixing Method, Cement Deep Mixing Column, Simplified Design.

## Introduction

In recent years design and construction of infrastructure facilities arising due to extensive urbanization and industrialization in soft clay zones has considerably increased. The soil improvement technique, called Deep Mixing Method (DMM), is often applied for improve the strength of the treated soft ground in Mekong Delta areas. The properties of the soil in this area are high water content, low stiffness and less frictional angle and less cohesion as well. This type of soil, in geotechnical engineering point of view, is known as an unstable soil since the soil will cause relatively large settlement when it is loaded, due to high excess pore pressure and reduction of effective stress within soil mass. The large settlement of the embankment, which is one of typical example of civil structure constructed on the soil layer, is the unstable behaviors of the soft soil during heavy loading.

There are several methods used for stabilizing the soft soil such as Mekong Delta soil. Soil improvement technique is often needed to rapidly improve the strength of the treated ground Georg Kempfert and Berhane Gebreselassie, 2006). The DMM is an in situ soil treatment and improvement technology whereby the ground is blended with cementitious and/or other materials to form a vertical stiff inclusion in the ground. These materials are internationally referred to as “binders” and can be introduced in slurry or dry form. They are injected through hollow, rotated mixing shafts tipped with some type of cutting tool. In this technique, physical and chemical reactions between cement, clay minerals, and water including hydration, pozzolanic reaction (cementation), ion exchange, flocculation, precipitation, oxidation, and carbonation are allowed to take place deep below the ground to produce a high-strength product quickly which will continue to strengthen with time and lower permeability, and lower compressibility than the native ground CDIT (2002).

In the chemical point of view, CDM method is used to reduce the high water content in the soil mass by absorbing the water molecule during the cementations of CDM column. In the mechanical point of view, the CDM method is used to increase the stiffness of soil mass by the high stiffness of CDM column (Bengt B, Homs. 1999). In these methods, the settlement of the soil layer is calculated by the consolidation index and the bearing capacity is check by the strength of the CDM column and the bearing capacity of the soil. And Zaika stated soils-soft defined as soils consisting compression (high) then strength -low in high content of water.

The stability of CDM column stabilized embankments can be analyzed either by a numerical calculation method such as the finite element method (FEM) or by a limit equilibrium method. The numerical calculation methods require reliable material parameters as determined by field and laboratory tests or in-situ on excavated columns and on the unstabilized soil. Another method considering simplified method is limit equilibrium method. In analysis of this method, the stability of CDM column is analyzed by assuming that failure of the CDM columns and the soil. In this chapter, the mechanism of CDM method and design method are reviewed.

## Mechanism of Cement Deep Mixing Method

### 1. Load Transfer Mechanisms

CDM columns is installed as isolated columns constructed using single-axis equipment, depending on the purpose and ground conditions, CDM column can be configured in typical arrangement patterns panels of overlapping columns, cells of overlapping columns, or blocks of overlapping columns. Column type is separately installed most easily under the pattern of square, triangular, or hexagon grid and the construction machine is simple. Regardless of the CDM column arrangement, the concepts of area replacement ratio, $a_s$, and stress concentration ratio, n, are common to all design procedures. For isolated CDM columns, the area replacement ratio is defined as the ratio between the area of the CDM column, $A_{col}$, and the total area, $A_{col} + A_{soil}$, (soil and CDM column) associated with that CDM column:

$$a_s = \frac{A_{col}}{A_{col} + A_{soil}} \quad (1)$$

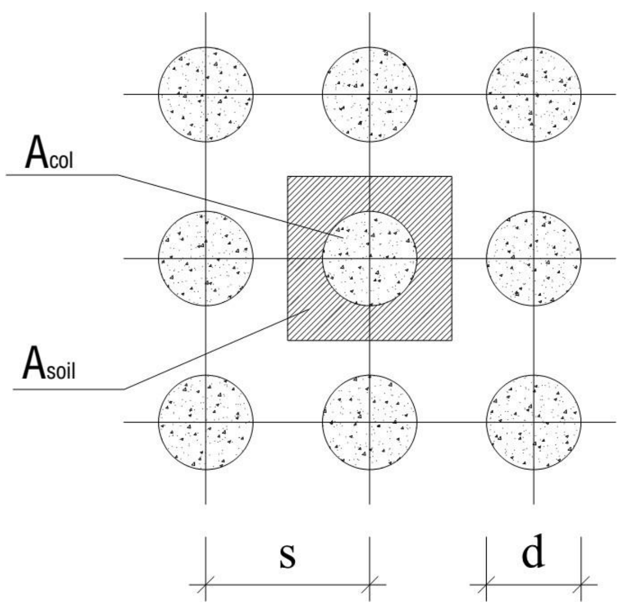



**Figure 1 Area replacement ratio**

Considering distribution of load on CDM columns and soft soil under a road embankment, average load is applied by the embankment:

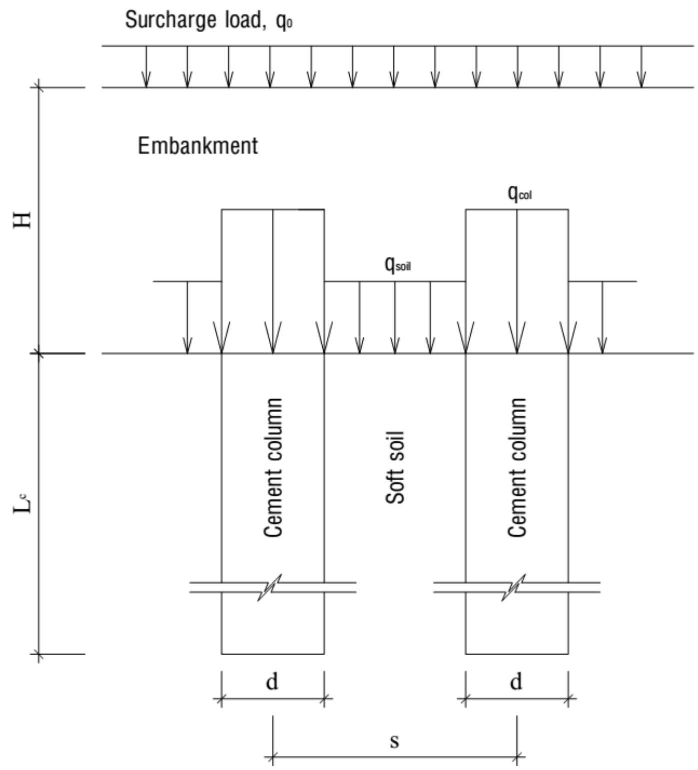



**Figure 2 Illustration of load distribution for CDM columns**

$$q = \gamma_{emb} H + q_0 \quad (2.a)$$

$$q = q_{col} . a_s + q_{soil} .(1 - a_s) \quad (2.b)$$

Where H is embankment height; $\gamma_{emb}$ is unit weight of embankment; $q_0$ is surcharge load, q is the applied unit load, $q_{col}$ is the load at the top of the CDM column; $q_{soil}$ is the load at the top of the soil between the CDM columns.

The vertical load carried by the CDM column:

$$q_{col} = \frac{q}{E_{eq}} E_{col} \quad (2.c)$$

The vertical load carried by the surrounding soil:

$$q_{soil} = \frac{q}{E_{eq}} E_{soil} \quad (2.d)$$

Where

$$E_{eq} = E_{col} a_s + (1 - a_s) E_{soil}$$

$E_{eq}$ is equivalent modulus of elasticity of the soil – CDM column; $E_{col}$ is modulus of elasticity of the CDM column; $E_{soil}$ is modulus of elasticity of soft soil layer.

## 2. The Ultimate Bearing Capacity of the Single CDM Column

Examination of practice design aspects for stability of embankment stabilized by DMM columns, CDIT (2002) took precaution that the DMM column failures can occur in rupture or and collapse due to bending and tilting, and thus internal stability of DMM columns should be also considered in design. Consequently, evaluating the failure of DMM columns beneath the embankment under many differential conditions, such as, due to bending, shearing, compression etc. is necessary work in practice design of embankments.

The ultimate bearing capacity of a single CDM column depends both on the skin friction resistance along the surface of the CDM column and on the end resistance. Equilibrium force, the total failure load:

$$\overline{Q_{ult}} = Q_{ult,soil} + W_{col} = Q_b + Q_s + W_{col} \quad (3.a)$$

$$Q_{ult,soil} = Q_b + Q_s \quad (3.b)$$

Where $\overline{Q_{ult}}$ is total failure load; $Q_{ult,soil}$ is ultimate bearing capacity of a single cement column; $Q_b$ is the base resistance of the cement column due to end bearing; $Q_s$ is shaft resistance of the cement column due to skin friction and $W_{col}$ is weight of the cement column.

Bergado, D.T. et al. (1996) said the shaft resistance of the cement column can be written in equation (3.c):

$$Q_s = A_s f_s \quad (3.c)$$

IN WHICH:

$A_s$: area (surface) of length -embedded of cement column;

$f_S$ □ $q'_o$ $K_S$ tan□ I.e skin friction

of it; $\overline{q'_0}$ : overburden pressure (average effective) over depth, embedded, of cement column; $\overline{K_S}$ is the coefficient (average, lateral earth pressure); □ defined as friction (angle) of soil between columns.

The base resistance of the cement column can be calculated using formulations as written in equation (3.d) from Karl Tezaghi and Ralph B. Peck (1996).

Webology (ISSN: 1735-188X)
Volume 19, Number 1, 2022

$$Q_b = \left(cN_c + q'_0 N_q + \frac{1}{2}\gamma d N_\gamma\right) A_{col} \qquad (3.d)$$

In which d defined as cement diameter; $q'_0$ defined as pressure (effective overburden) at cement column (end); c defined as soil cohesion, $\gamma$ defined as soil weight - effective unit, $N_c$, $N_q$, $N_\gamma$ as bearing capacity factors defining based on soil properties.

The cement column is installed in cohesive soil such as clay, organic or peat soil. For cohesive soil, $\phi = 0$, $N_q = 1$ and $N_\gamma = 0$. Base load -ultimate from equation (3.c) is:

$$Q_b = \left(cN_c + q'_0\right) A_{col} \qquad (3.e)$$

The net ultimate base load is,

$$\overline{Q_b} = Q_b - q'_0 A_{col} = cN_c A_{col} \qquad (3.f)$$

V.N.S. Murthy (2003) said the Meyerhof's method of determining $Q_b$ for column in clay soil ($\phi = 0$) and $N_c=9$. The base resistance is expressed as:

$$Q_b = N_c c_{u,soil} A_{col} \qquad (3.g)$$

$$= 9 c_{u,soil} \times A_{col} \qquad (3.h]$$

$$Q_s = A_s \times \alpha c_{u,soil}$$

Where $c_{u,soil}$ is undrained shear strength of the soil at the end of the cement column. Therefore, the ultimate bearing capacity of the cement column:

$$Q_{ult,soil} = Q_b + Q_s = \left(\alpha \pi d L_c + 9\frac{\pi d^2}{4}\right) c_{u,soil} \qquad (3.i)$$

## 3. The Undrained Soil-cement Strength (Compression)

The **undrained soil-cement strength (compression)** stabilized with cement is usually higher than that of soil - undisturbed about 1 - 2 hrs post- mixing. At favorable condition, stable soil-undrained shear strength is as high as 0.5 to 1.0 MPa. 10 to 50 times increase of the strength is expected.

D.T. Bergado (1996) estimate s -ultimate bearing: (friction angle 30º).

□ ult

and □h defined as pressure between soil and columns (horizontal).

The long-term strength of stabilized cement columns, $q_{1,max}$, is 70~95% of the ultimate strength. Hence, the maximum load on a single cement column is given by:

$$q_{1,max} \; \square \; (0.7 \text{ to } 0.95) a_s \sigma_{ult} \quad (5)$$

## 4. The Settlement of Cement Column Grou

The total settlement of a structure supported on cement column is calculated as illustrated in Figure 4.

$$\square h \; \square \; \square h_1 \; \square \; \square h_2 \quad (6.a)$$

Where $\Delta h$ is the total settlement of embankment; $\Delta h_1$ is the settlement of the stabilized soil layer and $\Delta h_2$ is the settlement of the unstabilized soil layer.

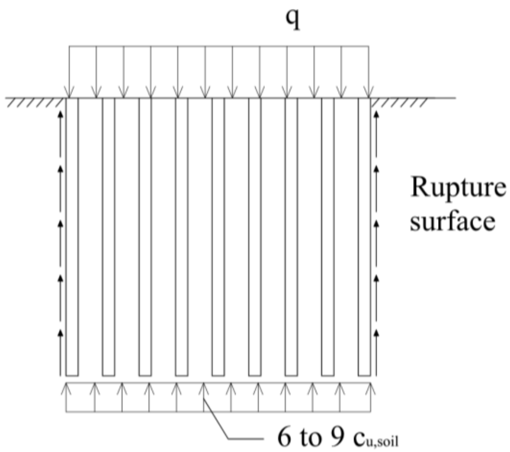



**Figure 3 Col.group - block (Shear failure)**

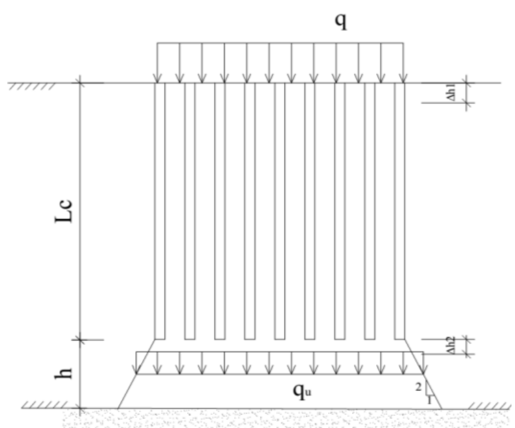



**Figure 4 The settlement of column(col.) group**

In case soil consolidated, col. of cement -settlement, $s_{col}$, and settlement of soil between the cement col.can be calculated

$$s_{col} = \sum \frac{L_c}{a_s E_{col}} \cdot q_{col} \quad (6.b)$$

$$s_{soil} = \sum \frac{L_c}{1 - a_s} \cdot \frac{q_{soil}}{E_{soil}}$$

( 6 . c]

Assumed the settlement of the cement column and the settlement of the soil between the cement columns are the same.

$$\Delta h_1 = s_{col} = s_{soil} = \sum \frac{L_c . q}{a_s . E_{col} + (1 - a_s).E_{soil}} \quad (6.d)$$

For floating cement column, oft Soil layer -settlement ($\Delta h_2$) below the end of the group of cement col. calculated using the standard calculation-settlement.

## 5. Capacity-bearing of Soil Beneath Embankment

Capacity-bearing of soil layers is evaluated using Terzaghi’s equation as written in equation (7).

$$R_{soil} = cN_c + \frac{1}{2} B \gamma'_H N_\gamma + \sigma'_D N_q \quad (7)$$

Where $R_{soil}$ as capacity of soil layer (ultimate bearing); c as soil cohesion; B is diameter of the cement column; $\gamma'_H$ is unit weight-effective beneath the embankment; $\sigma'_D$ as effective stress soil skeleton at the depth of D below ground level; $N_c$, $N_\gamma$, $N_q$ are bearing capacity factors defining based on soil properties, are shown in Figure 5.

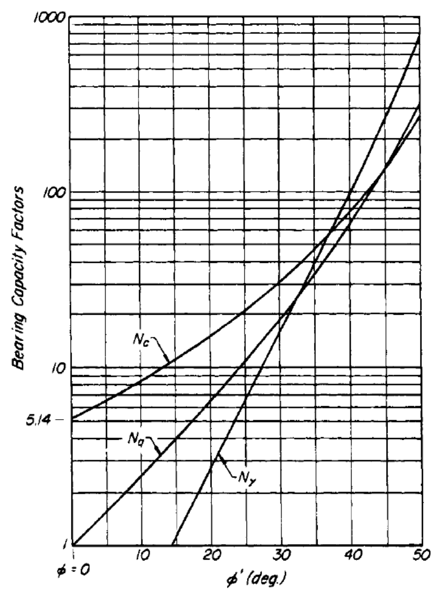



**Figure 5 Chart showing relation between bearing capacity factor and φ’ (Karl Tezaghi, Ralph B. Peck, 1996)**

## Optimum Cement Column Configuration by Method-Simple

Some factors such as allowable settlement, soil capacity affect cement col. Configuration. Method- simple or simplified is limit equilibrium method. Then We can use theory - consolidation for: analyzing cement col. Resistance, with Terzaghi's equation.

### 1. See Example Case Study Model

Look at fig. 6 for model shown and analyzed. There are 3 layers of soil in it, i.e., first is 11 m layer (soft soil), second is 4 m clay (silty) and third is 5 m sand (silty), respectively. ON soil layer (soft) there is construction of A 5 m high embankment structure and The embankment for passing a transportation highway. Then only model cross section shown here.

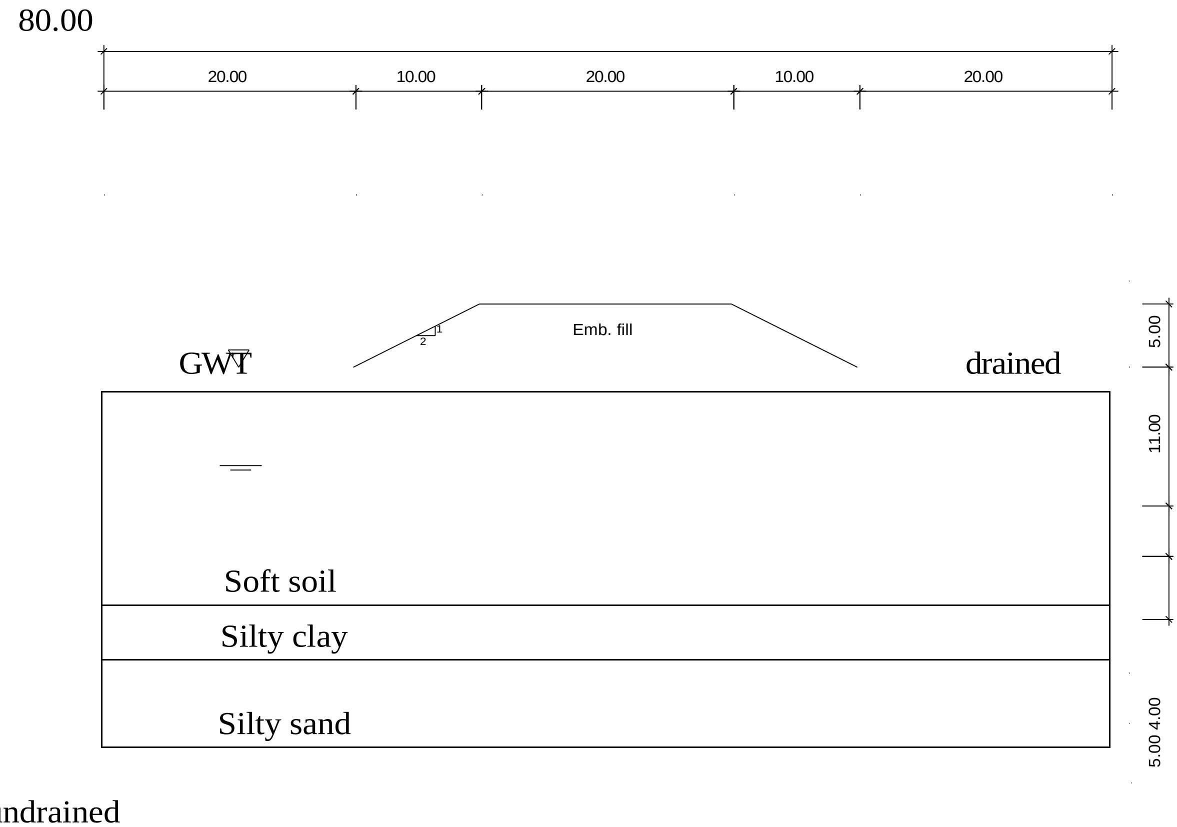



**Figure 6 Cross section of the embankment model**

The parameters of soil layers are defined according to field and laboratory test for the soil mass cored from the Mekong delta soil. Project: "Tan Huong Industrial Zone – Tien Giang – Vietnam". Detailed soil properties used in this study is below.

**Table 1 Soil layers (properties)**

| Parameters | OH (Soft Soil) | CL (Silty clay) | SM (Silty sand) | Unit |
|---|---|---|---|---|
| Saturated unit weight, □sat | 14.370 | 18.880 | 18.510 | $kN/m^3$ |

| | | | | |
|---|---|---|---|---|
| Young’s modulus, E | 3.048 | 6.028 | 7.434 | MPa |
| Cohesion, c | 0.0071 | 0.0131 | 0.0024 | MPa |
| Void ratio, $e_0$ | 2.389 | 0.705 | 0.604 | - |

## 2. Optimization of Configuration of the Cement Column by Using Simplified Method

The optimization of the cement column configuration using simplified method is conducted to define optimum diameter of cement column, the spacing (centre to centre of cement column) and length of cement column, when the applied load beneath the embankment is 120 kN/m$^2$. The optimum configuration has to satisfy allowable maximum settlement 0.4 m beneath the embankment according to Vietnamese Standard for transportation road, TCVN 22TCN 262-2000.

The simplified method is started by evaluating the bearing capacity of soil layers using Terzaghi equation as written in equation (8):

$$R_{soil} = cN_c + \frac{1}{2}B\gamma' N_\gamma + \gamma' D N_q \quad (8)$$

Where $R_{soil}$ as capacity of soil layer-ultimate bearing; c as cohesion of soil; B is embankment width; $\gamma'_H$ as unit weight beneath the embankment(effective); $\sigma'_D$ as stress soil skeleton (effective) at the depth of D below ground level; $N_c$, $N_\gamma$, $N_q$ are bearing capacity factors defining based on soil properties.

The bearing capacity calculated in equation (8) respect to depth of soil layers below the embankment structure, is plotted as shown in Figure 7. A maximum bearing capacity of soil layer on the level -11 m (soft soil layer) is around 115 kN/m$^2$. The capacity is relatively low comparing with the applied load beneath of embankment, which is 120 kN/m$^2$.

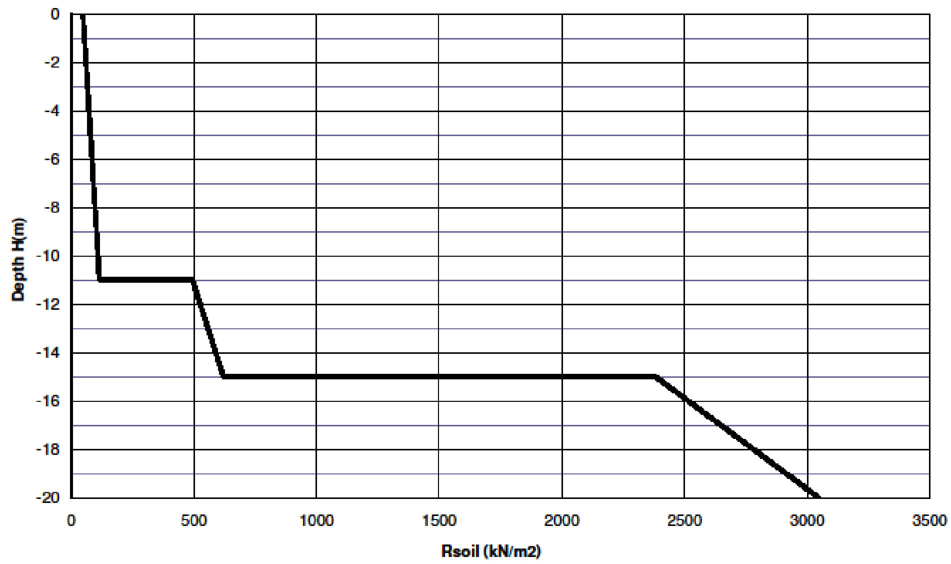



**Figure 7 Bearing capacity of soil layers beneath the embankment**

As explained in article 1, a main purpose of cement column type for stabilizing soil layers is to reduce the large settlement beneath the civil structures. Soil layer settlement (total) beneath the embankment calculated using consolation formulations as written in equation (9).

$$s_i = \frac{h_i}{1+e^i_o} C_c \log_{10}\left(\frac{\sigma'^i_{vz}+\sigma^i_z}{\sigma'^i_{vz}}\right) \quad (9)$$

where $s_i$ as layer (settlement) i; $h_i$ as layer I (thickness); $e^i_o$ as layer i- initial void ratio; $C^i_c$ as layer I compression index; $\sigma'^i_{vz}$ defined as vertical effective stress by gravity loading above the soil layers at center of the layer i; $\sigma^i_z$ as additional vertical effective stress of the layer i.

According to equation (9), the settlement caused by applied loading is more than 2 m. This settlement is relatively large compared with the allowable maximum settlement by Vietnamese Standard.

Using material properties given in Table 2 and equation 10 to 14, ration-min (area of the cement col.) in square of stabilized area is investigated for the different dimensions of cement column.

**Table 2 Material properties of cement column**

| Parameter | DCM column | Unit |
|---|---|---|
| Saturated unit weight, $\gamma_{sat}$ | 15.810 | $kN/m^3$ |
| Young's modulus, E | 43.750 | MPa |
| Cohesion, c | 0.175 | MPa |
| Frictional angle, $\varphi$ | 30.00 | degree |
| Void ratio, $e_o$ | 1.532 | - |

$$Q_{col} \leq Q^{max}_{ult,col} \quad (10)$$

$$Q_{col} \leq Q^{max}_{ult,soil} \quad (11)$$

$$Q_{col} = q_{col} \cdot A_{col} \quad (12.a)$$

$$q_{col} = \frac{q}{E_{eq}} E_{col} \quad (12.b)$$

$$E_{eq} = E_{col} a_s + (1 - a_s) E_{soil} \quad (12.c)$$

$$a_s = \frac{\pi}{4}\left(\frac{d}{s}\right)^2 \tag{12.d}$$

$$Q_{ult,soil}^{max} = \frac{\left(\pi d L_c + 2.25\pi d^2\right) c_{u,soil}}{FS} \tag{13}$$

$$Q_{ult,col}^{max} = \frac{A_{col} \cdot q_{1,max}}{FS} \tag{14.a}$$

$$q_{1,max} = 0.95 a_s \sigma_{ult} \tag{14.b}$$

$$\sigma_{ult} = 3.5 c_{u,col} + 3\sigma_h \tag{14.c}$$

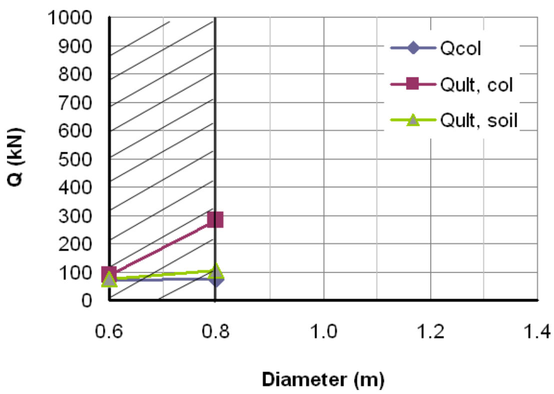
$$\sigma_h = \sigma_v + 5 c_{u,soil} \tag{14.d}$$

$$\sigma_v = q + \gamma' L_c \tag{14.e}$$

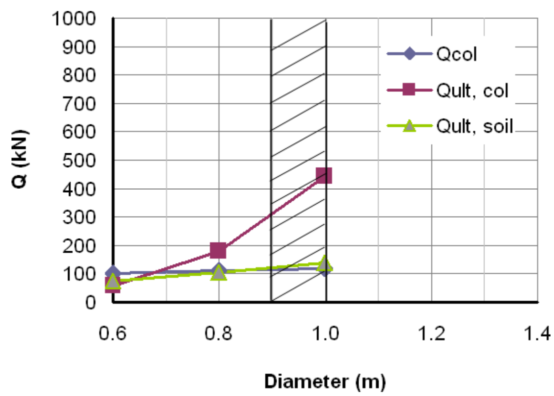
where $Q_{col}$ is the load at the top of the cement col.; $Q_{ult,soil}^{max}$ defined as capacity of single cement column (ultimate bearing) -surrounding soil strength; $Q_{ult,col}^{max}$ as capacity of single cement column (ultimate bearing)- the col. material strength; $E_{eq}$ as equivalent modulus of elasticity of the soil – cement column; $E_{col}$ as elasticity modulus of cement col.; $E_{soil}$ as elasticity of soft soil layer - modulus; q defined as unit load-applied; $A_{col}$ defined as cross col. section ; $a_s$ defined as ratio of area (replacement); $L_c$ defined as col.length; d as col.diameter ; s defined as col. centre spacing; $c_{ucol}$ defined as col.-undrained strength; $c_{usoil}$ as surrounding soft soil-undrained strength; FS as safety factor; $\sigma_{ult}$ as capacity of a single col. (ultimate internal bearing); $\sigma_h$ as pressure b.t soil and the col. (horizontal); $\sigma_v$ as total overburden pressure; $\gamma'$ defined as weight of buoyant unit.

In this study, the application of the simplified method is done by varying the diameter of cement column of 0.6 m, 0.8 m, 1.0 m, 1.2m and 1.4m, respectively; the spacing of centre of cement column of 0.8 m, 1.0 m, 1.2 m, 1.4 m, 1.6 m and 1.8 m, respectively; length of cement column of 7.0 m, 9.0 m and 11 m, respectively. The calculation results according to this simplified method are plotted as shown in Figure 8 to 10. The shaded area on these curves suggests the satisfying condition given in equations 10 and 11. The optimum configuration is indicated by the lowest ratio of cement column, which is calculated using equation 12.d. The values for shaded areas on curves in Figure 8 to 10 are tabulated in Table

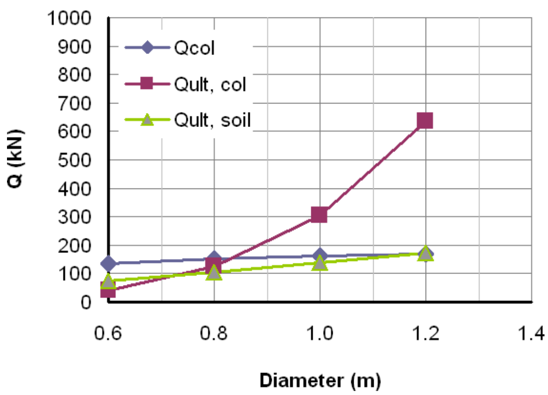
**3.** Based on the results in Table 3, the optimum configuration for stabilizing soil layer for this case is indicated that the diameter is 0.6 m, spacing is 0.8 m for the length of 7.0 m, 9.0 m and 11.0 m.



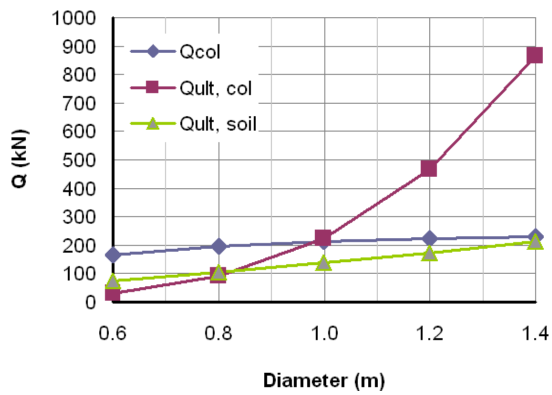
**(a) Spacing s= 0.8 m**



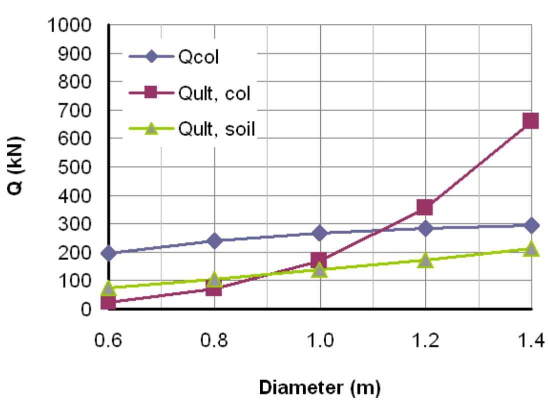
**(b) Spacing s= 1.0 m**



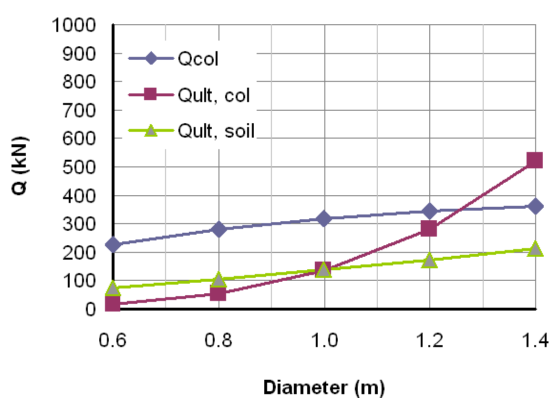
**(c) Spacing s= 1.2 m**



**(d) Spacing s= 1.4 m**

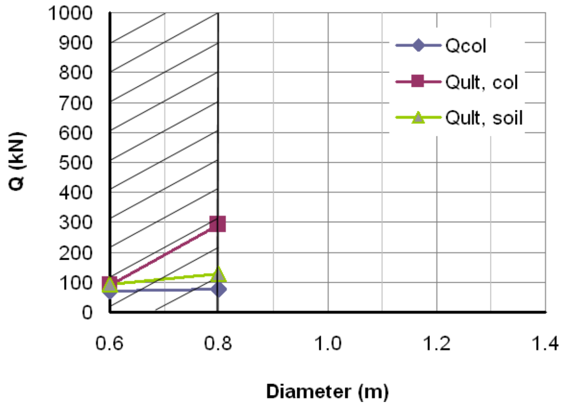


**(e) Spacing s= 1.6 m**

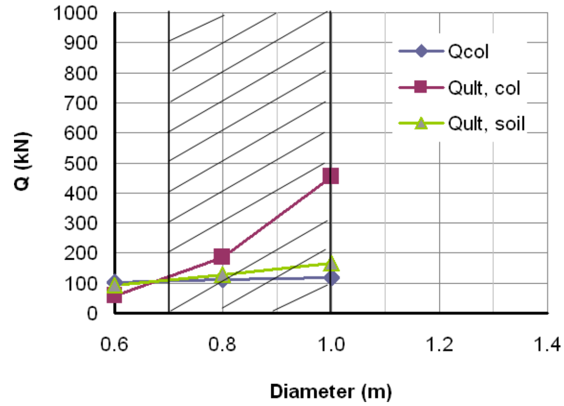


**(f) Spacing s= 1.8 m**

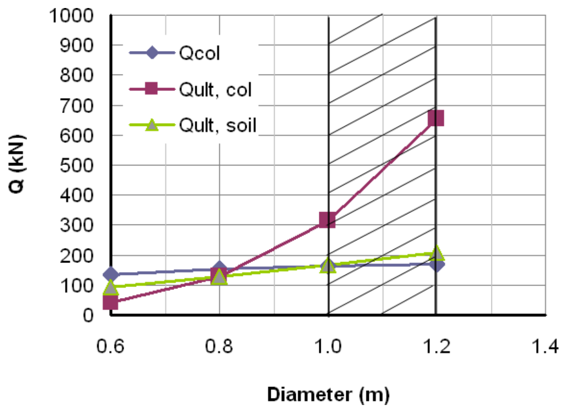
**Figure 8 Bearing capacity of different diameter of cement column for L= 7.0 m**



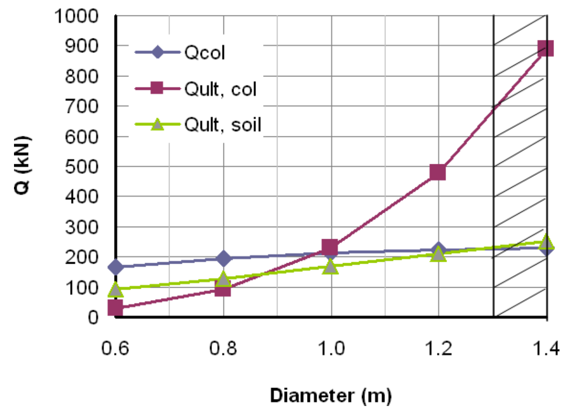

**(a) Spacing s= 0.8 m**



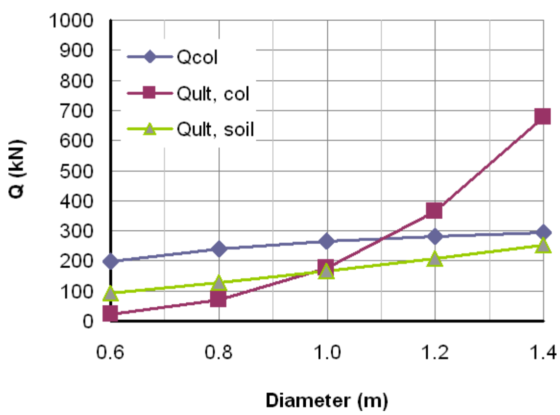

**(b) Spacing s= 1.0 m**



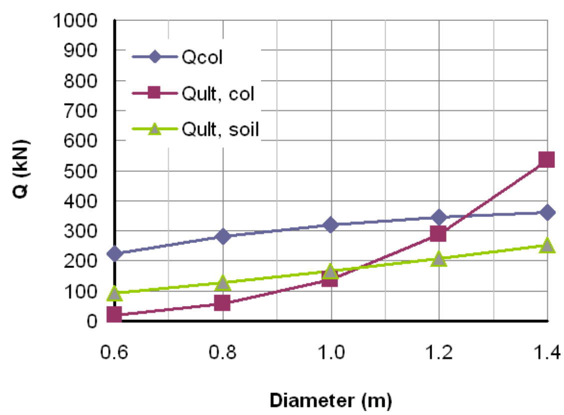

**(c) Spacing s= 1.2 m**




**(d) Spacing s= 1.4 m**

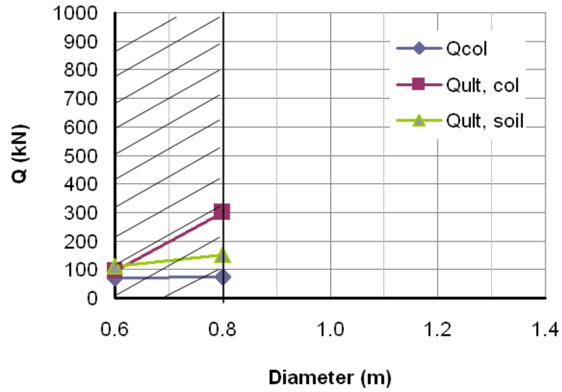



**(e) Spacing s= 1.6 m**

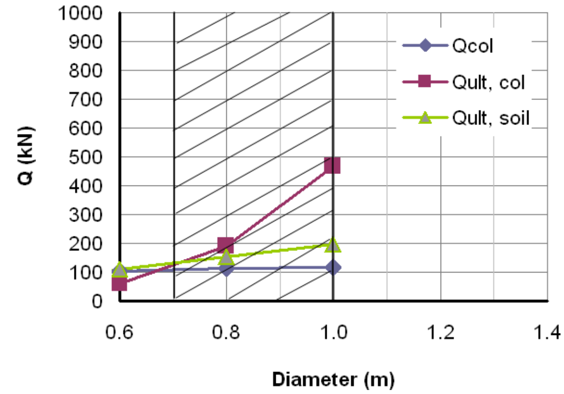



**(f) Spacing s= 1.8 m**

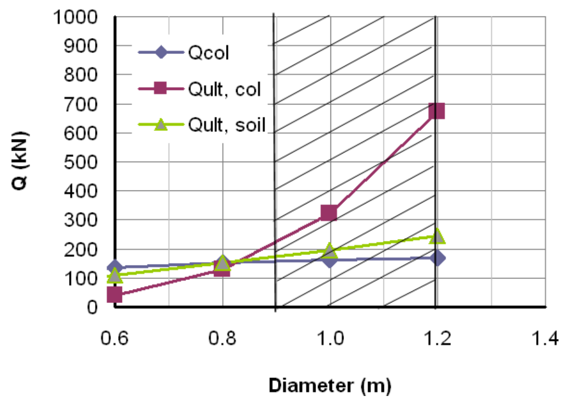
**Figure 9 Bearing capacity of different diameter of cement column for L= 9.0 m**



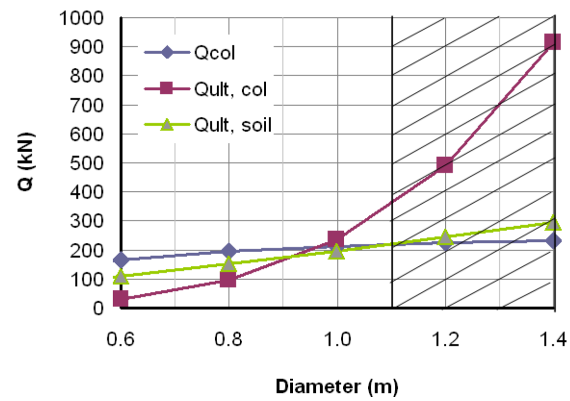

**(a) Spacing s= 0.8 m**



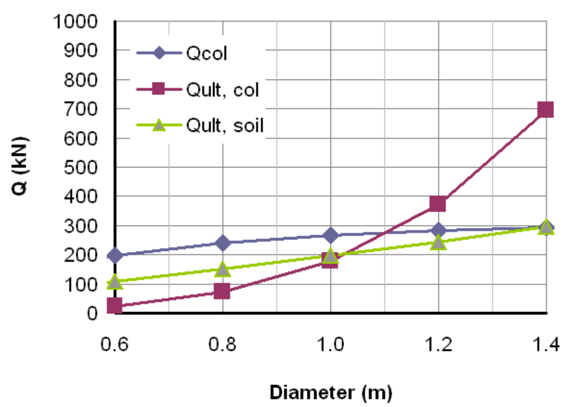

**(b) Spacing s= 1.0 m**



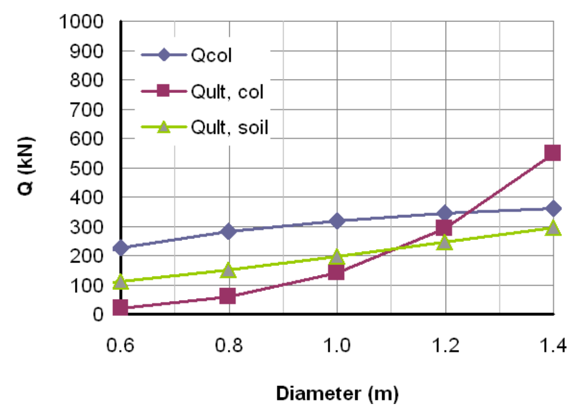

**(c) Spacing s= 1.2 m**




**(d) Spacing s= 1.4 m**




**(e) Spacing s= 1.6 m**




**(f) Spacing s= 1.8 m**

**Figure 10 Bearing capacity of different diameter of cement column for L= 11.0 m**

**Table 3 Values of ratio of cement column area**

| **Length L (m)** | **Spacing s= 0.8m** | **Spacing s= 1.0m** | **Spacing s= 1.2m** | **Spacing s= 1.4m** |
|---|---|---|---|---|
| 7.0 | d: 0.6m<br>as: 0.442 | d: 1.0m<br>as: 0.785 | d: 1.2m<br>as: 0.785 | - |
| 9.0 | d: 0.6m<br>as: 0.442 | d: 0.8m<br>as: 0.502 | d: 1.0m<br>as: 0.545 | d: 1.4m<br>as: 0.785 |
| 11.0 | d: 0.6m<br>as: 0.442 | d: 0.8m<br>as: 0.502 | d: 1.0m<br>as: 0.545 | d: 1.2m<br>as: 0.557 |

The final step in this simplified method is evaluating the settlement beneath the embankment after using cement column. The total settlement after stabilizing is accumulation of the settlement of stabilized soil and original soil and it is given in the equation 15.

$$\Delta h = \Delta h_1 + \Delta h_2 \quad (15.a)$$

$$\Delta h_1 = \frac{qL_c}{a_s E_{col} + (1 - a_s) E_{soil}} \quad (15.b)$$

$$\Delta h_2 = \frac{h}{1 + e} C_c \log_{10} \left( \frac{\sigma'_{vz} + q_u}{\sigma'_{vz}} \right) \quad (15.c)$$

0

Where □h is the total settlement of embankment; □$h_1$ is the settlement of the stabilized soil layer and □$h_2$ is the settlement of the soil layer below the column, as shown in Figure 4; and $q_u$ is stress of applied load at the middle of soft soil, below the stabilized soil layer.

According to equation 15, the total settlement is 0.169 m for the case with column length of 11m. This settlement is less than the allowable maximum settlement 0.4 m. The optimum configuration of cement column is the diameter of 0.6 m, the spacing of 0.8 m and the length of 11 m.

## Conclusions

The analytical study for design the optimum configuration of the cement column to stabilize the soft soil layer on the Mekong delta area has been described. In this study, the Simplified Method derived based on established formulations in soil mechanic is proposed to defined initial configuration of the cement column embedded on soft soil layer.

Cement col. Configuration (optimum) affected by Method-Simplified for embankment stabilization where we use current formula (current design) to calculate bearing capacity /settlement.

Authors find out deformation/stress distribution is vital to estimate cement col. Configuration (by Method - Deep Mixing), when comparison of Method -Simplified result and FEM analytical results.

## References

22TCN262-2000. The specification of surveying and designing the motorway sub-grade on soft ground, Ministry of Transpot, Vietnam, 2000.

Broms, B. (2017). Keynote lecture: Design of lime, lime/cement and cement columns. In Dry Mix Methods for Deep Soil Stabilization, 125-154.

Bergado, D.T., Anderson, L.R., Miura, N., & Balasubramaniam, A.S. (1996). Soft ground improvement in lowland and other environments. AsCE, 234-304.

Coastal Development Institute of Technology-CDIT, The Deep Mixing Method: Principle, Design and Construction, A.A. Balkema: The Netherlands, 2002.

Huy, D.T.N., Loan, B.T.T., & Pham, T.A. (2020). Impact of selected factors on stock price: a case study of Vietcombank in Vietnam. Entrepreneurship and Sustainability Issues 7(4), 2715.

Engineering Geological Report. Project: “Tan Huong Industrial Zone – Tien Giang – Vietnam”, 05/2000.

Han-Georg Kempfert and Berhane Gebreselassie, Excavations and Foundation in Soft Soil, Krips bv, Meppel, 2006.

Terzaghi, K., Peck, R.B., & Mesri, G. (1996). Soil mechanics in engineering practice. John

Wiley & Sons.
Murthy, V.N.S. (2002). Geotechnical engineering: principles and practices of soil mechanics and foundation engineering. CRC press.
Huy, D.T.N. (2012). Estimating Beta of Viet Nam listed construction companies groups during the crisis. Journal of Integration and Development, 15(1), 57-71.
Hanh, H.T., Le Thi Viet, N.G.A., Huy, D.T.N., Lan, L.M., & Dat, P.M. (2020). The Quantified Analysis of Causes of Market Risk Fluctuations in the Group of Construction, Real Estate and Construction Material Companies in Vietnam During and after the Global Crisis 2007-2011. WSEAS Transactions on Environment and Development, 16, 189-197.
Huy, D.T.N. (2015). The Critical Analysis of Limited South Asian Corporate Governance Standards After Financial Crisis. International Journal for Quality Research, 9(4).
Tinh, D.T., Thuy, N.T., & Ngoc Huy, D.T. (2021). Doing Business Research and Teaching Methodology for Undergraduate, Postgraduate and Doctoral Students-Case in Various Markets Including Vietnam. Ilkogretim Online, 20(1).
Shen, G., Manafian, J., Zia, S.M., Huy, D.T.N., & Le, T.H. (2021). The New Solitary Solutions to the Time-Fractional Coupled Jaulent–Miodek Equation. Discrete Dynamics in Nature and Society, 2021.
Shen, G., Manafian, J., Huy, D.T.N., Nisar, K.S., Abotaleb, M., & Trung, N.D. (2022). Abundant soliton wave solutions and the linear superposition principle for generalized (3+ 1)-D nonlinear wave equation in liquid with gas bubbles by bilinear analysis. Results in Physics, 32.
Manafian, J., & Lakestani, M. (2021). Interaction among a lump, periodic waves, and kink solutions to the fractional generalized CBS-BK equation. Mathematical Methods in the Applied Sciences, 44(1), 1052-1070.
Le Thi Thanh Huong, D.T., & Huong, D.T.N.H. (2021). Education for students to enhance research skills and meet demand from workplace-case in vietnam. Elementary education online, 20(4), 606-611.
Lan, N.T.H., & Huy, D.T.N. (2021). Developing students' mathematical competence through equipping them with necessary knowledge about metacognition-and activities in teaching mathematics in secondary school. Laplage em Revista, 7(3B), 24-35.
Thi Hang, N., Thi Tinh, D., Ngoc Huy, D.T., & Hong Nhung, P.T. (2021). Educating and training labor force Under Covid 19; Impacts to Meet Market Demand in Vietnam during Globalization and Integration Era. Journal for educators, teachers and trainers, 12(1).
Trung, N.D., Huy, D.T.N., Van Thanh, T., Thanh, N.T.P., & Dung, N.T. (2021). Digital Transformation, AI Applications and IoTs in Blockchain Managing Commerce Secrets: And Cybersecurity Risk Solutions in the Era of Industry 4.0 and Further. Management.
Dat, P.M., Mau, N.D., Loan, B.T.T., & Huy, D.T.N. (2020). Comparative China Corporate Governance Standards After Financial Crisis, Corporate Scandals and Manipulation. Journal of security & sustainability issues, 9(3).
Nhung, P.T.H., Huy, D.T.N., Nam, V.Q., & Hanh, H.T. (2021). Deepening Analysis on Internal Control Procedures of Cost Estimation Design in Road and Bridge Construction Units-and the Relation with Internal Audit. Revista Geintec-Gestao Inovacao E Tecnologias, 11(4), 2850-2869.

Chupradit, S., Raya, I., Ngoc Huy, D.T., Bokov, D., Van Tuan, P., Surendar, A., & Sajjadifar, S. (2021). Role of Glass Composition on Mechanical Properties of Shape Memory Alloy-Metallic Glass Composites. Advances in Materials Science and Engineering, 2021.

Zaika, Y., Fahara, A., Safira, N., & Darmawan, W. (2021). The Effect of Cement to Develop Strength of Grati Soft Soil. Geomate Journal, 21(86), 17-22.