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TUNNEL CONSTRUCTION IN BANGKOK CLAY

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#### บทคัดย่อ

วิทยานิพนธ์นี้ เป็นผลของการศึกษาการก่อสร้างอุโมงค์ส่งน้ำประปาในชั้นดินกรุงเทพฯ โดยบริษัทผู้รับเหมาญี่ปุ่น (Nishimatsu construction Co., Ltd., Ohbayashi Gumi Construction Co., Ltd.) และบริษัทผู้รับเหมาอังกฤษ (Sheridan Construction Co., Ltd.) อุโมงค์นี้มีเส้นผ่านศูนย์กลางตั้งแต่ 2.0 ถึง 3.4 เมตร อยู่ลึกประมาณ 20 เมตรจากผิวดิน โดยสร้างจากโรงกรองน้ำบางเขนไปยังสถานีสูบน้ำที่ลุมพินีและท่าพระ เป็นระยะทางประมาณ 25 กม.

ในการศึกษานี้ได้รวบรวมวิธีการก่อสร้างแต่ละขั้นตอนตั้งแต่เริ่มแรกจนสำเร็จ หลักการในการคำนวณออกแบบ ตลอดจนปัญหาเฉพาะหน้าที่เกิดขึ้นในขณะก่อสร้างและการแก้ไขปัญหานั้น ๆ จนสำเร็จลุล่วงไปโดยสมบูรณ์

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#### ABSTRACT

This thesis concerns the study of the water transmission tunnel construction in Bangkok clay by Japanese contractors (Nishimatsu construction Co., Ltd., Ohbayashi Gumi construction Co., Ltd. and British contractor (Sheridan construction Co., Ltd.) The tunnel diameter ranges from 2.0 to 3.4 m. and about 20 m. deep below ground surface. The construction begins from Bangkok water treatment plant to Lumpini and Taphra pumping station about 25 km. long.

The study includes every step of construction procedures from the beginning, concepts of designing, the field problems and the valuable remedial measures, resulting to a successful performance.

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## LIST OF SYMBOLS

A	area
B	width
c	cohesion of soil
C	gas concentration
$C_x, C_y$	bending moment coefficient for rectangular slab
D, d	diameter
$D_c$	critical depth
E	modulus of elasticity of the lining
$E_c$	modulus of elasticity of concrete.
$E_o$	modulus of elasticity of clay
$E_s$	modulus of elasticity of steel
$F_s$	Factor safety
f	friction coefficient
$f_b$	breaking stress of bolt
$f_c$	compressive stress of concrete
$f'_c$	cylindrical compressive strength of concrete
$f_s$	tensile stress of steel
$f_t$	tensile stress of concrete
$f_y$	yield stress of flange plate
$H_o$	theoretical water head of compressed air
J	moment of inertia
K	the ratio between horizontal and vertical pressure
$K_a$	coefficient of active earth pressure

$K_p$	coefficient of passive earth pressure
$L, \ell$	length
$M$	moment
$M$	modulus of soil reaction
$N$	Axial force
$N_c$	Dimensionless coefficient
$n$	modulus ratio
$p_a$	air pressure above atmospheric pressure
$p_i$	internal pressure of cylinder
$p_n$	horizontal earth pressure
$p_v$	vertical earth pressure
$p_r$	radial stress of the ground
$p_\theta$	circumferential stress of the ground
$Q_r$	unconfined compressive strength of disturbed sample
$Q_u$	unconfined compressive strength of undisturbed sample
$Q_s$	unconfined compressive strength of clay around shield
$Q$	shear force
$q$	surface surcharge
$q$	coefficient of horizontal subgrade reaction
$R$	skin friction
$R, r$	radius
$T$	Torque
$t$	time
$U$	uplift pressure
$U$	water pressure
$u$	radial displacement

V	volume
W	weight
w	subgrade reaction
$w_d$	horizontal subgrade reaction
Z	subgrade reaction
$\alpha$	off-axis deflection
$\delta$	deformation of the lining
$\epsilon$	strain
$\epsilon_r$	radial strain
$\epsilon_s$	tensile strain of steel
$\epsilon_t$	tensile strain of concrete
$\rho$	deformed radius
$\gamma$	unit weight of soil
$\nu$	poisson ratio of clay
$\phi$	angle of shearing resistance
$\theta$	relative orientation of the prisms
$\tau$	undrained shearing strength of soil
$\sigma$	normal stress of soil
$\sigma_r$	radial stress of the cylinder
$\sigma_o$	circumferential stress of the cylinder