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ACCESS ROAD IN THE EXTREME CONDITION BASED ON THE GEOTECHNICAL AND STRUCTURAL PERSPECTIVES (CASE STUDY IN GUNUNGPATI DISTRICT, SEMARANG-CENTRAL JAVA)

Ferry Hermawan [1], Himawan Indarto [2] and Hanggoro Tri Cahyo [3]

ABSTRACT: The Access is the backbone of zona development. Road infrastructure has an important part of the activities pattern in the urban or sub urban area. Gunungpati district is the one of conservation zone in Semarang, central java which has extreme geographical performance. Some problems are unstable slope, risk of soilcreep, poor drainage system, even system structure expensively matter in the settlement area. In the future the South Ring Road will be built across the Gunungpati district it mean that problems must be solved comprehensively. Some previews study about Gunungpati and simulation with some approach like isoprice map, trajectory of public transport, soil properties analysis with geotechnical modelling and structural model are briefly describe the threatment efforts of the extreme condition. The result of the study are the alternatives to treat the condition of transportation system, geotechnical phenomenon and safety of structural system for settlement area.

Keywords: access,infrastructure, transportation system, geotechnic, structural engineering.

BACKGROUND

The center of gravity will be the point to which the average distance per person is the shortest. One can also identify special areas of the city such as its central business district (CBD). One will be able then to calculate what is the average distance per person to the CBD and whether the CBD and center of gravity coincide. **Suen (2005)** was study about residential development pattern is characterized by residential parcel density and an aggregated parcel shape index. Factor analysis shows that the length of streets is an appropriate indicator to represent overall infrastructure provision. Logarithmic multiple regression analysis reveals a good relationship between residential development pattern and infrastructure provision variables. Parcel shape has a stronger influence on infrastructure provision than parcel density does, and together they explain more than 55% of the variation in infrastructure provision. The results of this empirical study establish a means to evaluate development proposals on the basis of development pattern and the associated infrastructure provision cost**.** Spatially, the Semarang people growth direction to South East and South of Semarang City. Starting along corridor Pedurungan district in the southeast and commencing to Banyumanik, Tembalang and Gunungpati in the south of Semarang. Landused of south district concentrated as settlement area. Spatial growth of the people from the expansion district era in 1994 until 2006. There are two phase of settlement growth in semarang, first step is liniear along the regional access to Southeast and South district, then braided growth as a network within the dense resident of settlement area. **(Hermawan and Ismiyati, 2009).** Access Road is the backbone of zona development of activities and economic growth. Gunungpati is the one district in Semarang which geographically extreme. Most of area category is hillyslope, poor aquifer and unstable slope in some places like Sekaran, Kalisegoro and Kandri subdistrict. In the future The City Goverment has a policy that South Area of Semarang would be connected by Southern Ring Road as suburban access. But the fact is the extreme condition of Geographics was impacted to the infrastructure along the main access road. Some of realestats and structures was damaged by natural creep, sliding in the long process, erosion induce by rain because of poor drainage and non engineered structure was build the high slide risk area.

[1] Lecturer, Civil Engineering Departement of Diponegoro University (UNDIP), Jl. Prof. Sudharto,SH Tembalang, Semarang, Central Java, Phone: +62 24 7474770, Cell: +62 811271463 , Fax: +62 24 7460060, e-mail: hermawan.ferry@gmail.com, bppsonline@yahoo.com, Indonesia
[2] Lecturer, Civil Engineering Departement of Diponegoro University (UNDIP), Semarang Central Java, Indonesia
[3] Lecturer, Civil Engineering Departement of State University Semarang (UNNES), Semarang Central Java, Indonesia

PROFILE OF GUNUNGPATI

Gunungpati area is about 5399.085 hectare with total family about 1158 in 2006. The annual growth of people is 1.16 procent. The people lies in this district totally 62.647 persons. Transportation mode area motor cylcle (33.3%), auto (14.1%), public transport (35.6%) and walking (17%). **Triwibowo (2006) and Berdikari (2006) . Ismiyati (2005) and Hermawan (2008)**. The Characteristic detail see Table 1.

Table 1. Characteristic of Gunungpati

Parameter	**Value**
Area (ha)	5399.085
Total Family (KK)	1158
Total People (person)	62.647
Annual Growth of People	1.16
Annual Motorcycle Growth	3.79
Annual Private Vehicle Growth	27.49
Load Factor Peak (Max, Min) (%),Traject	Max:104,97 (B17), Min: 42,11 (B09)
Travel Time peak (Max, Min) (%),Traject	Max: 155(B10) ,Min: 131 (B17)
Trajectory lenght (Max,Min) (km)	Max: 59(B17) ,Min: 30 (B09)
Overlap trajectory, Road Segment	Max: 4, Manyaran Gnpati, Min: 2, Gnpati Ung, Sekaran
Total overlap(km), trajectory	Max: 8,77 (B10), Min: 1,26 (B17)
Isoprice to CBD (in IDR)	3000- 10000

Source: Hermawan (2008)

Gunungpati has an extreme condition. Along the main access entering the district has a hilly land with high value of slope between 15-30% **(Wahib, 1993)**, and the certain place has slope until 40% to 50%. The most extreme slope along the East area. The detail of slope map see figure 1.

Based on Detail Planning of City (RDTRK), Gunungpati included in BWK VIII consist of 16 subdistrict. From the constlellation inter zone that Gunungpati district located in the transportation line connected to Ungaran City-Gunungpati and Mijen district. Gunungpati has a hinterland function from CBD of Semarang as Conservation Zone and Growthpole of buffer facilities to local and regional access. Topographically, Gunungpati district actually difficult as established area. Factually

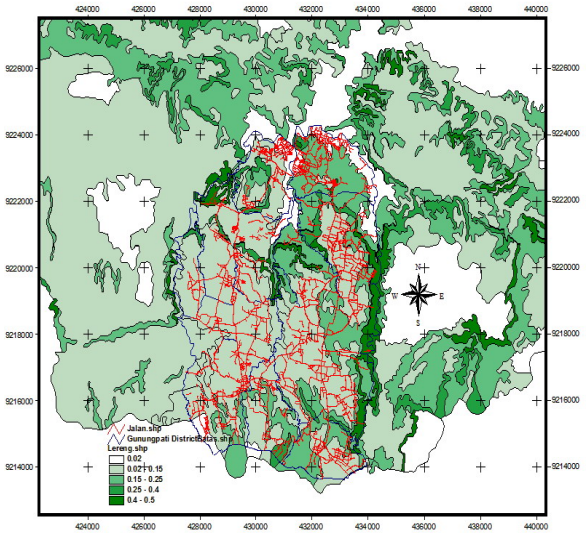

Figure 1. Slope Condition at Gunungpati
(Source: Goverment of Semarang City, 1999 and Analysis, 2009)

There were a few trajectory of public transport perform the accessibility in Gunungati. The service area of public transport served by 4 trajectory (B09, B10, B17 dan B44). The other trajectory is R.3d. Traject networking as shown in figure 2.

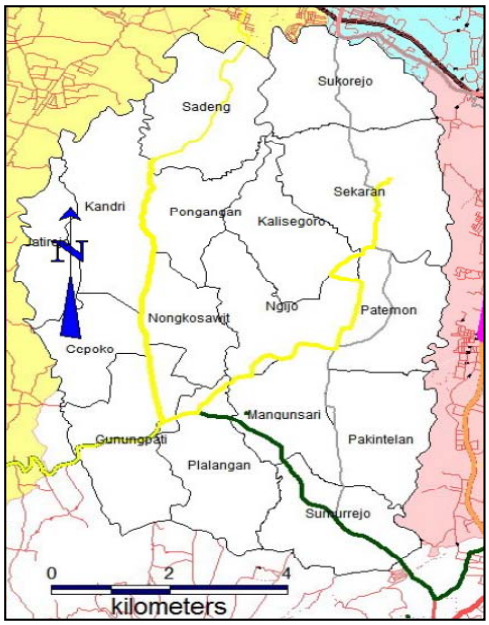

Figure 2. Public Transport Trajectory at Gunungpati
(Source: Hermawan, 2008)

The daily frequency of public transport at Gunungpati performance indicated by yellow line at figure 2. Because of geographical barrier, there are only four access road to central district of Gunungpati such access from Kendal, Ungaran, from Abdulrahman Saleh (Ngaliyan District) and from Sampangan (Sekaran District. That situation proofed with the mobility pattern

of Gunungpati that the internal mobility is about 42,5% then the external mobility about 0.8% to 20% **(Berdikari, 2006 and Ismiyati, 2005).** The maximum proportion of mobility commencing to South of Semarang. See the figure 3 for detail.

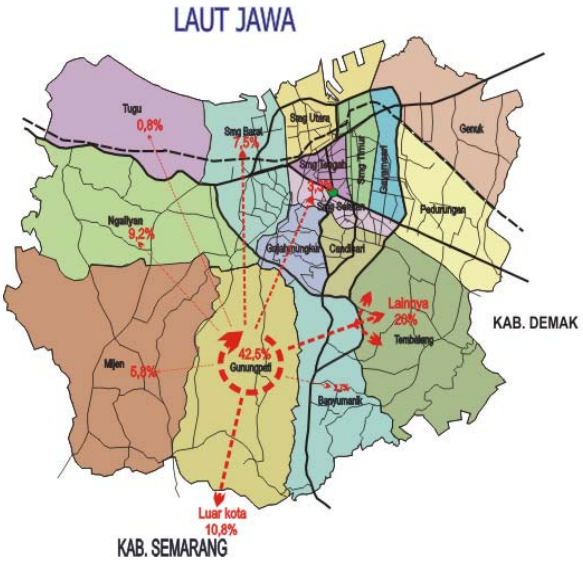

Figure 3. People Mobility Pattern at Gunungpati (Source: Berdikari (2006), Ismiyati (2005)

The other previews study of mobility modeling by **Hermawan (2008), Hermawan, Basuki and Riyanto (2008) and Hermawan, Ismiyati and Riyanto (2008)** corresponding with mode usage (motor cycle, private car and public transport). By regression linier approach the people mobility represented as table 2 below.

Table 2. Model Mobility-Mode at Gunungpati

Regression Model
Y=2.100+0.284X1+1.586X2-0.403X3

R	R^2	Sig.
0.946	0.895	0.000

Sources: Hermawan. (2008)

Note: Y = people mobility to CBD; X1= total public transport usage; X2= total motor cycle usage; X3= total private vehicle ownership

The public transport mode was served the Gunungpati district by medium bus and passenger car. The main road segment is urban road with 3 lane. The geographical barrier and the extreme condition of geological and geotechnic are the reason why the accessibility become important. That's the background of Southern Ring Road in the future which connecting Gunungpati to the other districts.

GEOTECHNICAL AND STRUCTURAL REVIEW ON STUDY AREA

Bore pile behavior of structure in extreme zone

There were a lot of phenomenon of geotechnic at Gunungpati. This paper will describe previews study along the main access from Sampangan at Sakaran subdistrict taken from several realestate that failed caused by extreme condition and wrong adjustment of constructions like selection of foundation type, foundation depth, arrangement of blockplan, treatment after cut and fill, design of slope stability etc.

This research simulated the sliding mechanism which probably happen at the hilly side of realestate that built on the Gunungpati district, also the borepile behaviour caused by lateral forces by finite element method (FEM). Softwate which FEM for geotechnical purpose usaged PLAXIS that use reduction of shear stress and element interface.

Review of landslide mechanism and behaviour of borepile caused by lateral force useful for adjust how reliable the structure and recovery after established. The input parameter for the simulation see tabel 3 below.

Tabel 3. Input Parameter of Finite Element Analysis Model

Identification	Type	γ_{dry} [kN/m^3]	γ_{wet} [kN/m^3]	v [-]	E_ref [kN/m^2]	c_u [kN/m^2]	φ [°]
Clay	Drained	16	17	0.3	3428	37.7	9.3
Lanau Kepasiran (Sandy Silt)	Drained	16	18	0.3	15000	10	30
Hard Soil	Drained	16	18	0.3	60000	10	40
Compacted soil	Drained	16	17	0.3	3428	37.7	9.3

Identification	Type	EA [kN/m]	EI [kNm^2/m]	w [kN/m/m]	v [-]	f'_c MPa	f_y MPa
Bor Pile D20, lenght = 6m	Elastic	637760	1594.4	0.7536	0.25	18	240

Source: Indarto, 2005

Slope modeled by 2 Dimension as plane strain with 15th nodes. Every house structure has 4 borepiles diameter's size D = 20 cm and the loading for Axial Column is 78,84 kN and the allowable bearing capacity from sondir is 67 kN. Distance of each column is 2 meters with q total= 7,92 kN/m' . The loading on existing and fully constructed see figure 4 and figure 5.

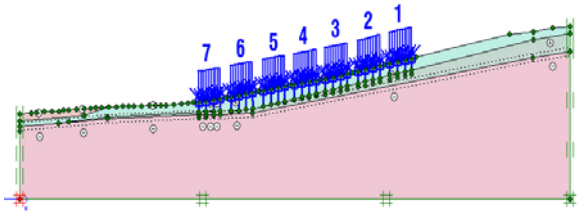

Figure 4. Load Model Existing at Location Study (Indarto, 2005)

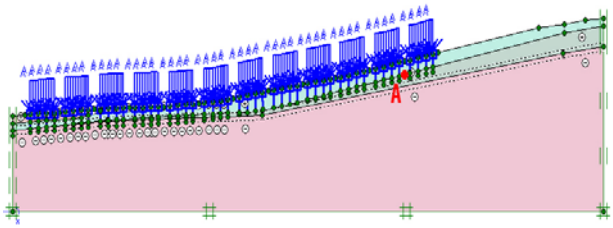

Figure 5. Load Model Fully Constructed at Location Study (Indarto, 2005)

The analytical model simulation focused on borepile deformation, moment, axial force and Shear of each pile, then the safety factor of slope stability for every R-interface used the Shear Strenght Reduction Finite Element Method (SSR-FEM).

The Result of Simulation perform that borepiles design by investors at study location could not defence the lateral forces. When the soil shear strength on the surface level with hard soil (qc= 200 kg/cm2) reducted until 25% or R-*inter* = 0,25 caused by rain induced sliding effect to borepile behavior with R- *inter* between 1 until 0.5. Based on the FEM when the R inter = 1 the lateral displacement is about 82.23 x 10^{-3} m need to be anticipated on structural design to avoid structural failure because of lateral movement could be minimized eventhough the Safety factor is still safe. The displacement on the existing condition and fully constructed see table 4.

Table 4. Total Displacement Existing and Fully Constructed (in meter)

R-inter	*Existing*	*Fully Constructed*
1.00	82.23 x 10^{-3}	81.83 x 10^{-3}
0.75	87.03 x 10^{-3}	86.59 x 10^{-3}
0.50	100.63 x 10^{-3}	100.15 x 10^{-3}
0.25	264.26 x 10^{-3}	293.22 x 10^{-3}

Source: Indarto, 2005

Recent Condition of main access road at Gunungpati as shown at figure 6. Along Sekaran access road from Sampangan has dynamic geometrice on horisontal or vertical alignment. Near that access is also happened at Safira Realestate. Although the drainage system is good arrangement the soil creep on the entrance access was destroy the surface pavemen and the lateral force gradually made the structural failures.

Figure 6. (from left rotated to right) Sekaran access road- Entrance road of Safira Realestate and Structural Failure caused the owner's leaved the house.
(Source: Private Document, Hermawan, 2009)

Eventhough the location too extreme, the access build near the Safira 2 month later (November, 2009). The Village access road beside the Sekaran road made some exploitation but the construction not concern about the safety of infrastructure along the Sekaran road. For example the retaining wall only one side constructed, it means that stability of highway foundation become unstable performance, even the drainage not directed to the good system and soil coverage is destroyed and potentially induced sliding when its rain. See the figure 7 for detail situation.

Figure 7. Village Access Opening beside Safira Realestate along the Sekaran Road (Source: Private Document, Hermawan, 2009)

Between the extreme condition, there were stable area because of the geographically the slope is more steep. For example at Bumi Sukorejo and Trankil Sejahtera estate (see figure 8).

Figure 8. Bumi Sukorejo and Trankil Sejahtera has more stable area in Gunungpati. (Source: Private Document, Hermawan, 2009)

TRANSPORTATION INFRASTRUCTURE CHALLENGE AT THE EXTREME CONDITION

Hermawan (2008) , **Hermawan and Ismiyati (2009)** was used the isoprice model with Geographic Information System tools to describe the cost transport of the people. By questionair and price index of cost transport in 3 subdistric (Banyumanik, Tembalang and Gunungpati area) along the public transport traject. He was measured the high dense of residential ratio and length of road network ratio per residential area has a good service performance of public transports although the amount of mode was inefficient because many overlapping public transport trajectory in that area. The cost transport to CBD more expensive at Gunungpati, its ranges about IDR 3.000-10.000 (see the map on figure 9).

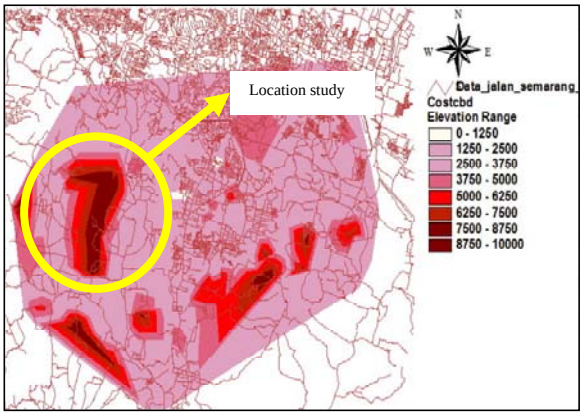

Figure 9. The Isoprice Map on Study Area (Hermawan, 2008 and 2009)

Gunungpati has a little amount of trajectory becaused of some barriers such slope stability, landuse policy as conservation zone and limited infrastructure. **Hermawan (2008)** sugest the type of transportation mode for Gunungpati district is only for medium bus or passenger car for supply the door to door service. Limited road capacity and soil stability caused the infrastructure have to geographical based. There are a challenges at Gunungpati to develop situation based on the extreme condition such as Eco-Tourism transportation by connected with sub urban area Banyumanik, Tembalang and a part of Ungaran or Kendal. Conservation Zone means the vegetations or plant it's the core of prevetion way to keep the slope stabilization naturally.

CONCLUSION AND FUTURE STUDY

Conclusions

1. Risk of construction based on geotechnical simulation performed that extreme condition has an high cost for construction eventhough the structural supporting by length of borepile foundation.
2. Recovery cost for highway at the extreme condition was very expensive because of annual maintenance only overlay without some efforts to stabilize the slope by environmental friendly method's.
3. The development of Gunungpati should depend on the landused policy as conservation zone, so sustainable treatmen such as plantation and good arrangement of drainage in every corner of settlement. It means that the Southern Ring Road planning must take a deep analysis for geotechnical and structural reviews for minimized the construction cost and failure cost.
4. Extreme condition related with the Isoprice map that the cost of transport to CBD relatively expensive than nearest sub urban area like Banyumanik or Tembalang.

Future Study

Gunungpati as a case study need comprehensive study because the extreme condition related with infrastructure problems. It can not be partially solved like only geotechnic aspect or structural aspect or transportation aspec or urban development aspect etc. Sinergy and harmony of conservation zone is must be realized.

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