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IMPROVEMENT OF THE SUB BASE MATERIAL WITH A CBR LOWER THAN 25% BY MIXING THE LIME STONE POWDER (CaCo3)

VERNSONE PHENGSOULITH, KHAMSEUM SOURIYAMATH, PHOUTHONE SAIYASENH, ART MALAVONG
Faculty of Engineering,National University of Laos
*Corresponding author: E-mail: ern.phl86@yahoo.com

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ABSTRACT

Sub base is the layer of aggregate material laid on the subgrade, on which the base course layer is located. It may be omitted when there will be only foot traffic on the pavement, but it is necessary for surfaces used by vehicles. The sub base material shall consist of hard durable particles or fragments of granular aggregates. Sub base mobilization by using limestone **(**$CaCO_3$**)** is intended to determine the change of the bearing capacity of the soil as California Bearing Ration (CBR) with a mixture of lime**.** Soil behavior is strongly influenced by the moisture or water content. According the requirements of pavement design, CBR of sub base materials must be greater than 25 to support the load from traffic vehicles that's the reason it is really rare to be able to find from natural borrow pits to meet the requirements. ASTM standard was applied for lab activities. The results found that the plastic index (PI) was decreased and influenced to the increasing of CBR by amount of lime powder adding. From lab result shown that the PI of soil sample is 15% and CBR is 10, 12 and 14% at 95%, 98% and 100% of maximum dry density (OMC=14.2%; MDD=1.806kg/cm^2) respectively. To meet the requirements of Sub Base material, lime was added (5%, 10% and 20%) to minimize the PI and strengthening the bearing capacity and found that the PI was decreased to 13%, 9% and 9% while CBR value were increased to 13, 16 and 18% when compacted at 95%, 98% and 100% of MDD respectively. The PI was continuously reduced to 9% when 10% of lime was added and CBR were increased to 20, 24 and 27% when compacted at 95%, 98% and 100% of MDD respectively. 20% of lime was applied and influenced the PI decreased to 9% and increased the CBR to 40, 51 and 59% when compacted at 95%, 98% and 100% of MDD respectively. From the result of the research adding from 10% of lime powder was near accountable to the requirements of sub base material from this sample.

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Introduction

Sub base is the layer of aggregate material laid on the subgrade, on which the base course layer is located. It may be omitted when there will be only foot traffic on the pavement, but it is necessary for surfaces used by vehicles. The sub base material shall consist of hard durable particles or fragments of granular aggregates. This material will be mixed or blended with fine sand, clay, stone dust, or other similar binding or filler materials produced from approved sources. The quality of sub base is very important for the pavement structures and for the life use of the road. According the requirements of pavement design, CBR of sub base materials must be greater than 25 to support the load from traffic vehicles.

More than 70% of Laos is mountainous with

typically above 500 meters laid through the north region of the country. In the north of Laos are plenty of mountains with high to steep terrain and elevations where the soil contents high moisture hence the sub base materials are really rare to be able to find from natural borrow pits to meet the requirements. Soil in the high terrain mostly covered by dense clay with great for planting and agricultural purposes but it is not really suitable for Engineering aspects such as road pavement, backfill for civil works and etc.

Mixed sub base materials are widely used through the country and most of them mix from natural soil from borrow pits and hard rock stone hence makes the cost of sub base materials getting high from materials cost, transport cost and also mixing cost.

The improvement or modification of sub base materials is mostly required to enhance the CBR value to meet the requirements in terms of technical and also economic aspects.

The objectives of this study are:

- To investigate the properties of borrow pits with high level/terrain
- To enhance the CBR value by mixing the lime stone powder ($CaCo_3$) to deduct the plastic index
- To optimize the rate of lime stone powder ($CaCo_3$) adding to modify the bearing capacity of Sub Base Course from selected soil pit

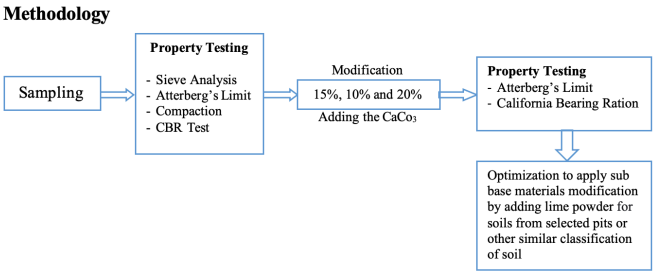

Figure 01: Research Conceptual Flow Charge

Sampling

2 borrow pits in Khoun District, Xiengkhouang Province were selected since sub base material modification or stabilization is required for pavement purposes in this area (Phaton and Nam Pueak Pits).

Figure 02: Sampling at Phaton Pit

Figure 03: Sampling Nam Phuak Pit

Lab works

The lab was conducted in main lab of Road-Bridge Department Faculty of Engineering which samples were prepared.

Figure 04: Lab Preparations

The properties of samples from both pit were tested included sieve analysis, Atterberg's Limit test, Compaction and CBR test

Figure 05: Soil Property Tests

Lime powder was added to deduct the plastic index (PI) and strengthening the bearing capacity or CBR which based on

the properties of the sample, 5%, 10% and 20% of lime was mixed to modify the properties of soil by influenced to PI and CBR

Figure 06: lime preparation

Compaction and CBR were tested to evaluate the properties of modified materials

Figure 07: The properties of modified materials testing

Results and discussion

Properties of soil samples

Sieve Analysis, Atterberg's Limit, Compaction, CBR Tests were conducted to investigate the properties of soil samples from both Nam Phuak and Phaton pits and we found that the properties of both pits were quite low in terms of mechanical aspects as shown in the table below:

Table 01: The results of testing the properties of soil from Pits

SAMPLE DETAILS	PARTICLE SIZES DISTRIBUTION % PASSING SIEVE SIZE									ATTERBERG LIMIT			COMPACTION T 180		% CBR WHEN COMPACTED AT		
	40.0	28.0	20.0	10.0	6.3	2.00	1.00	0.425	0.075	LL	PL	PI	MDD kg/cm2	OMC (%)	100	98	95
Phaton Pit	100.0	100.0	97.0	86.0	80.0	72.0	68.0	65.0	20.0	34.0	19.0	15.0	1.806	14.2	14	12	10
Nam Pueak Pit	100.0	100.0	100.0	84.0	79.0	74.0	72.0	59.0	52.0	44.0	23.0	21.0	1.548	24.3	3.4	2.6	1.4

Lime powder by 5%, 10% and 20% were mixed to modify the properties of soil by influenced to PI and CBR. From the results, we found that the Plastic Index was some deducted after adding the lime powder which more lime resulted the PI was decreased while CBR was increased that means the bearing capacity was strengthened by lime mixture as shown in the table below:

Table 02: The results of testing the properties of soil after adding lime

SAMPLE DETAILS	PARTICLE SIZES DISTRIBUTION % PASSING SIEVE SIZE									ATTERBERG LIMIT			COMPACTION T 180		% CBR WHEN COMPACTED AT		
	40.0	28.0	20.0	10.0	6.3	2.00	1.00	0.425	0.075	LL	PL	PI	MDD kg/cm2	OMC (%)	100	98	95
Adding 5% of lime	100.0	100.0	97.0	86.0	80.0	72.0	70.0	63.0	22.0	32.0	19.0	13.0	1.814	13.6	18	16	13
Adding 10% of lime	100.0	100.0	96.0	82.0	77.0	70.0	67.0	59.0	22.0	28.0	19.0	9.0	1.863	13.3	27	24	20
Adding 20% of lime	100.0	100.0	99.0	91.0	86.0	80.0	77.0	69.0	31.0	31.0	22.0	9.0	1.908	13.3	59	51	40

Table 03: The results of CBR testing after adding 5% of lime

CBR TEST DATA				COMPACTION TEST DATA	
ເບີໂມ (Mold Number)	A5	B9	A16		
ຈຳນວນບາດຕຳ (Number of blow)	10	30	65	LAB.SAMPLE No	
ເບີໂມ (Dry Unit weight)	1.699	1.783	1.833	MDD,g/Cm^3	1.814
ເປີເຊັນ ຊີບີອາ (CBR %)	12	16	19	OMC,%	13.6
ຄ່າສະມັດທະພາບຂອງການຮອງຮັບຢູ່ທີ່ຈຸດຄວາມແໜ້ນ100 % ຂອງ MDD =	1.814	g/Cm3	CBR =	18.0	%
ຄ່າສະມັດທະພາບຂອງການຮອງຮັບຢູ່ທີ່ຈຸດຄວາມແໜ້ນ 98% ຂອງ MDD =	1.778	g/Cm3	CBR =	16.0	%
ຄ່າສະມັດທະພາບຂອງການຮອງຮັບຢູ່ທີ່ຈຸດຄວາມແໜ້ນ 95% ຂອງ MDD =	1.723	g/Cm3	CBR =	13.0	%

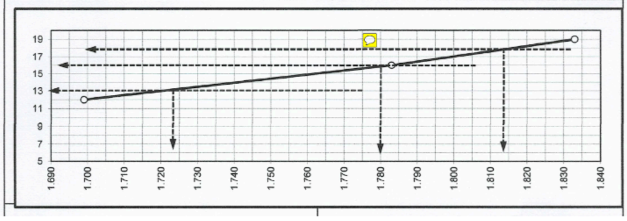

Table 04: The results of CBR testing after adding 10% of lime

CBR TEST DATA				COMPACTION TEST DATA	
ເບີໂມ (Mold Number)	A10	B9	B30		
ຈຳນວນບາດຕຳ (Number of blow)	10	30	65	LAB.SAMPLE No	
ເບີໂມ (Dry Unit weight)	1.679	1.783	1.870	MDD,g/Cm^3	1.863
ເປີເຊັນ ຊີບີອາ (CBR %)	15	21	27	OMC,%	13.3
ຄ່າສະມັດທະພາບຂອງການຮອງຮັບຢູ່ທີ່ຈຸດຄວາມແໜ້ນ100 % ຂອງ MDD =	1.863	g/Cm3	CBR =	27.0	%
ຄ່າສະມັດທະພາບຂອງການຮອງຮັບຢູ່ທີ່ຈຸດຄວາມແໜ້ນ 98% ຂອງ MDD =	1.826	g/Cm3	CBR =	24.0	%
ຄ່າສະມັດທະພາບຂອງການຮອງຮັບຢູ່ທີ່ຈຸດຄວາມແໜ້ນ 95% ຂອງ MDD =	1.770	g/Cm3	CBR =	20.0	%

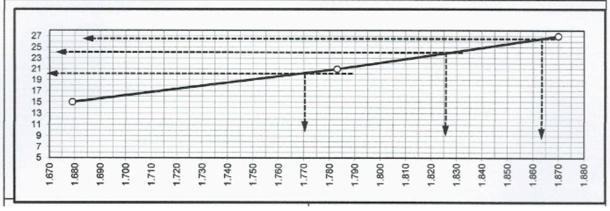

Table 06: Summarize of CBR testing after adding lime powder

No	Adding Ratio	PI	CBR when compacted at		
			95%	98%	100%
1	0%	15	10%	12%	14%
2	5%	13	13	16	18
3	10%	9	20	24	27
4	20%	9	40	51	59

Conclusion

The results found that the plastic index (PI) was decreased after adding the lime powder and influenced to the increasing of CBR by amount of lime added. From lab result shown that the PI of soil sample from pit is 15% and CBR is 10%, 12% and 14% when compacted at 95%, 98% and 100% of maximum dry density (OMC=14.2%; MDD=1.806kg/cm^2) respectively. To meet the requirements of Sub Base material, lime was added (5%, 10% and 20%) to minimize the PI and strengthening the bearing capacity and found that the PI was decreased to 13%, 9% and 9% while CBR value were increased to 13, 16 and 18% when compacted at 95%, 98% and 100% of MDD respectively. The PI was continuously reduced to 9% when 10% of lime was added and CBR were increased to 20, 24 and 27% when compacted at 95%, 98% and 100% of MDD respectively. 20% of lime was applied and influenced the PI decreased to 9% and increased the CBR to 40, 51 and 59% when compacted at 95%, 98% and 100% of MDD respectively. From the result of the research, adding from 10% of lime powder was near accountable to the requirements of sub base material from this sample.

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