SOME PARTICULAR TRAITS OF ALLUVIUM IN THE LOWER SECTION OF RED RIVER IN VIETNAM

Nguyen Thanh SON
Chief of Geotechnical Engineering Dept.
Research Institute for Transportation Science and Technology
2 - Duong Lang - Hanoi - VIETNAM
Tel.:84.4.8344199 Fax: 84.4.8343403

abstract: Alluvium process in the Red river affects to the waterway. The research on current's nature and movements has been paid much attention by General Department of Metrology, Hydrology and Waterway Transport Department.The Alluvium process depends on seasons. The flow is very complicated, especially the operation of the silt flow and turbulent current. The formation of Alluvium banks stretching along the river also affect the Alluvium. The report highlights some investigation data on the flow, silt content and silt settlement's regulation of the Red river's lower section. It mentions also the Alluvium process and its affect to the waterway transport.

1. TOPOGRAPHICAL-GEOTECHNICAL CHARATERISTIC OF THE RED RIVER'S LOWER SECTION

1.1 Location

Red river originates from Daily lake of China, flows to the direction of North West-South Earth and empties into Tonkin gulf at Balat mouth with length of 510 Km.

Red river's lower section with the area of about 15,000Km^2 is limited in the North West direction by Viettri city, where Red, Da and Lo rivers integrate. In fact, Red river is a river system including many sub-rivers fixing as tree-branch shape. After passing SonTay Red river is divided into 5 sub-rivers: Duong, Luoc, TraLy, NamDinh and NinhCo. Duong and Luoc connect with ThaiBinh river to form a river system of Red River Delta, where Red river and ThaiBinh river are main river flowing to direction of North West-South Earth. During the time of 2 million years, a vast area of 154,000 Km^2 has been formed from Red river.

1.2. Topography

The topography of Red river lower section is affected by present alluvium process under river currents, sea waves, tidies and coastal sea-currents. The alluvium and erosion process and rising up and down process with the time of continents have caused the complicated characteristic of Red river downstream topography. In addition, human's activities as building dikes, irrigation, transportation and exploiting materials have affected greatly topography of river's banks. Topography of Red river Delta is relatively flat with small slope and divided by river system in to hollow section covered by dike system so that the unsynchronous silt alluvium leads to rapidly change of topographical height; many alluvium islands appear right on the middle of the rivers make the currents complicated and benignly with small slope (0.2-0.5m/Km).

The topography of river mouth area is affected by the tide. The daily tide regime in TonKin gulf affects directly the currents making the flow velocity slow down when tides come up and contrariwise. Especially in dry season the tide affects current more strongly, contrary direction flow velocity is up to 1-2m/s. When the tide comes up, the tidal current can reach 5-10 Km beyond the mouth of the Red rive. It can be said that alluvium process in this area plays a main role.

1.3. The geological structure of Red river.

The result from the survey made on the geology and the natural geography show that Red River Delta formed in the pletosen and Holosen period (IV Era). Considering aspect of the geographical situation, the procedure of alluvium and erosion from time to time has formed subsoil. This process which taking place complicatedly depending on the features of terrain and streams, leading to complicated geographical structure nowadays. The subsoil can have a thickness varied from metre to several metres. The stratum in area of Red river mainly is aged QIV^{1-2} another part in the North aged Q^{II-IV}.

2. HYDROGRAPHICAL REGIME OF THE RED RIVER'S LOWER SECTION.

2.1. Currents in rainy season

There were so impressive floodings of Red river in 1893,1945 and 1971 that flow velocities were extreme high (4-5m/s), amplitude of water levels were up to 10m, the height of water level could reach 7-8m/day. The water content in flooding season occupies 75-85% water content of the whole year. The most terrible floods often occurs in August and the water content in this month occupies 25-35% water content of the whole year. Therefore, in flood season the erosion capacity is grater than alluvium capacity. The current network for waterway transport has been changed mainly to the straight direction.

2.2. Currents in dry season

The dry season lasts form October to May of the year after (8 months) with small water flow velocities (1-2m/s). The currents have small alluvium and erosion capacity but its directions often change making the river bedding a lot. Many dry rapids develop along the rivers. The more the rapids are near the river's mouth the bigger the sizes of dry rapids are that changing the current network for waterway transport.

3. CHARACTERISTICS OF THE RED RIVER'S SILT AND EROSION AND ALLUVIUM PROCESS

3.1. The area without being affected by tides

The erosion and alluvium process happen continuously and they are affected greatly by flow velocities, muddy-sandy density and status of the rivers.

Muddy-sandy density is muddy-sandy amount contended in $1m^3$ of water. Muddy-sandy density of Red river in flooding season is greater 5-10times in comparison with dry season.

Table1. Muddy-Sandy density

No	Station	Average/year (g/m^3)	Average/flooding season (g/m^3)	Average/ flooding season (g/m^3)
1.	Lao Cai	3050	3350	710
2.	Yen Bai	1700	1840	370
3.	Son Tay	1400	1160	340
4.	Ha Noi	940	1080	332

Table 2. Particle characteristic of silt of Red river downstream

Particle size (mm)	<0.005	0.005-0.010	0,010-0.015	0.015-0.025	0.025-0.050	0.050-0.075	0.075-0.100
1970							
Son Tay	19.5	10.6	7.4	8.5	10.9	10.2	9.0
Ha Noi	30.9	15.0	8.6	11.5	14.0	7.8	5.8
1992							
Son Tay	30.7	14.3	7.6	9.6	10.8	8.4	7.5
Ha Noi	27.0	14.1	8.8	11.5	14.0	8.5	6.4

In order to determine the erosion and alluvium lays of the river, it is necessary to know the muddy-sandy loading capacity (A). The greater the silty loading capacity is, the greater the erosion capacity is than alluvium and contrariwise.

$$A = K\left(\frac{V^3}{g\,h\,\omega}\right)^m$$

Of which, A: Muddy-sandy loading capacity: V: Water flow velocity (m/s);
g: Gravity acceleration; h: depth; K,m: Parameters changing with each river section (at Son Tay K=155, m=0.87, at Hanoi K=88.8, m=0.922).

The muddy-sandy loading capacity of Red river downstream is very small (especially in dry season so many alluvium islands and dry rapids are formed making the current bending. In dry season, dry rapids affect the waterway transport, in many section only vessels with capacities less than 200 T can pass.

Dry rapids can be classified into: good rapids, bad rapids and distributive rapids depending on their influences on inland waterway transport. According to Grisanin K.V they are classified into 6 types depending on the causes to form them and their shapes as well.

3.2. The area with being affected by tide

The topography of the river mouth area from the splash zone to the spreading zone of wave if affected by the tide. The alluvium and erosion process are alternative but the scale of alluvium is greater than erosion process. The common charateristic is that the embankment

is gently sloping and sea beach is large. Every year it invades the sea from 8-10m. At the Balat mouth the sea invaded speed can reach from 80-100m, at the Day mouth from 100-120m, at the both sides the silt from Red rive occupied up to 75-80%.

Table 4: Typical dry rapids in Red river downstream

No	Rapid	Km	Height		Δ(m)	λ(m)	R.c(m)
			Foot	Top			
1.	Ha Tan	25	-5.2	-2.2	7.4	8725	2900
2.	Phuong Do	38	-7.0	2.9	9.9	4825	3250
3.	Phuong Dinh	40	-5.1	1.6	6.7	2700	3250
4.	Lien Hong	64	-4.8	2.0	6.8	10675	1975
5.	Hai Boi	75	-12.1	-0.4	11.7	5150	3250
6.	Thach Cau	89	-11.9	0.0	11.9	5220	2825
7.	Van Phuc	103	-17.2	-1.7	15.5	8300	1500
8.	Van Diem	126	-15.8	0.8	15.0	7500	3100
9.	Phu Cuong	135	-21.5	-0.9	20.6	7500	2000
10.	Hoa Xa	147	-21.9	-0.9	21.0	7000	1650
11.	Dong Yen	160	-10.2	-1.5	8.7	12500	2700
12.	Thanh nga	169	-10.9	-1.8	9.1	12500	2750
13.	Hong Ly	178	-13.5	-4.0	9.5	10500	3250
14.	Tan Lap	183	-16.6	-3.6	13.0	3000	2850

Remark: Δ: the height of dry rapids; λ: the length of dry rapids; R.c. : radius of the river section at upstream of dry rapids.

4. AFFECTS OF THE ALLUVIUM AND EROSION PROCESSES ON THE WATERWAY TRANSPORT

4.1 Change of currents

The greatest change of the riverbed caused by alluvium and erosion processes happens in the section between SonTay to Phu Hao including HaNoi section. Before 1965 there were two main currents inclined to GiaLam side (at position of 650m and 820m). Since 1966 they had been gradually to Hanoi side and integrated to a main current in 1968. From 1969 to 1971 the river seemed to be stable but widen. Since 7/1971 main current had moved to GiaLam side, in 1975 it moved contrarily. It can be concluded that a cycle for moving from side to other side lasts 3-4 years which directly affect the operation of HaNoi river port. In dry season when the main current moves to GiaLam side, it is necessary to dredge river to make way for the port.

In the mouth area, alluvium process is complicated, especially the sea invaded speed is high making the border line of river currents change rapidly so in order to make waterway transport means safe in operation it is required to survey and investigate more often.

4.2. Affects of dry rapids

There have been many dry rapids developed along waterway transport system. Every 10Km there is a dry rapid which is not deep enough for transport means to pass. The river section of Son Tay-Ha Noi is often alluviumed with the total up to 815,000m^3/year. The riverbed is risen from 0.10 to 0.20 per year. Alluvium processes make the dry rapids rise higher so that the currents of area where dry rapids located are getting complicated. To ensure the depth for operating transport means, dredging work in Hanoi section is taken every year but that is the part solution not a overall solution the the whole line. Therefore, the operation capacity of waterway transport is limited. Developed law of dry rapids in Red river' lower section needs paying more attention in the survey work for the treatment.

5. CONCLUSION

The Alluvium process in the Red river's section happens continuosly and trends increasingly day by day so that the study on this matter is very important in the planning and developing waterway transport system in Red river Delta.

At present, although there are many constructions built for protect waterway network, it is not comprehensive and thorough. To improve the waterway line mainly by Dredging by its capacity is limited. The treatment and readjustment of river need to be paid more attention in order to operate the waterway transport more effectively contributing to infrastructure development in VietNam.

REFERENCES

Nguyen Viet Pho, Pham Quang Hanh (1984) **Flows of Vietnamese Rivers**. Nha Xuat ban Khoa hoc ky thuat, Hanoi (in Vietnamese).

Pham Ngoc Hoan, Phan Tan Dac (1987) **Vietnamese Climate**. Nha Xuat ban khoa hoc ky thuat, Hanoi.

Hoang Niem (1985) **Some Remarks on Water Quantities of Existing Rivers in Viet Nam.** Tap San Khoa hoc ky thuat Thuy Loi\, Hanoi (In Vietnamese)

Nguyen Tho Tiep (1995) **Character of the Relief Differentiation in the Nearshore Region of Red River Delta -** in **Contribution of Marine Geology and Geophysics.** Nha Xuat ban khoa hoc ky thuat, Hanoi.

Ben Avraham Z. (1978) **The Evolution of Marginal and Adjacent Shelves in East and Southeast Asia .** in **Tectonsphysics.** Pp 269-288.

UNESCO (1990) **Engineering Geological Maps.** UNESCO.

Kezdi A. (1980) **Handbook of Soil Mechanics.** Elsevier Scien. Publishing Co. Amsterdam-Oxford-New York.