博 士(工 学) デュラル クリスナ プラサード

学 位 論 文 題 名

ROLE OF COHESIVE SEDIMENT ON THE RIVER CHANNEL DEVELOPMENT

(河道形成における粘着性土質の役割)

学位論文内容の要旨

Management of river training and rehabilitation works as well as assessment of interaction between river structures and hydraulic and morphologic condition of the river is still an art despite numerous studies that have been conducted so far. Construction of different types of structures like bridge piers, abutments, river training and habitat improvement (spurs, vanes, bend-ways, fish-way etc) is of common practice in river engineering since many years. On the contrary, the applicability of such structures would be only significant if the structures serve for the purpose effectively that has been built for. However, the construction of the structures may cause negative environmental consequences on the one hand and the failure of the structure itself on the other.

Of most problems that have been facing in river engineering since long time, the uncontrolled migration is of great significance from practical engineering point of view. It appears that there is still lack of explorative and thorough observation on river migrations as well as planform evolution morphology. Number of physical evidences shows there has been always variation of planforms with the change in boundary conditions. Inadequacy of proper judgments for migrations and estimation for the quality and quantity of the future river planforms is thought to be underlying causes of negative environmental consequences as well as failure of structure. Likewise, construction of such structure is supposed to be economically efficient. Consequently, a reliable methodology for the assessment of the river planform evolution with consideration of the entire sediment composition on flood-plain is of significance in river engineering practice.

Intrinsically, this study can be characterized as an explorative with support from experimental findings and real observations. It has been attempted to quantify the problems associated with river migrations, planform variations in terms of various physical aspects. Furthermore, attempt has been made to bring the solution considering the facts that appear to be overlooked in earlier studies.

The sphere of knowledge that has been considered in this study is the experimental and field study related with river planforms evolutions with consideration of cohesion variation on the one part and the flood-plain strength evolutions, in particular failure strength against erosion, on the other part. Basically, the study was performed, in particular for both parts, making use of extensive physical investigations due to the complication of the phenomenon. The use of various level of cohesion in the sediment mixtures for same level of external boundary conditions helped to understand the whole

博 士（工 学） デュラル クリスナ プラサード

学 位 論 文 題 名

ROLE OF COHESIVE SEDIMENT ON THE RIVER CHANNEL DEVELOPMENT

（河道形成における粘着性土質の役割）

学位論文内容の要旨

Management of river training and rehabilitation works as well as assessment of interaction between river structures and hydraulic and morphologic condition of the river is still an art despite numerous studies that have been conducted so far. Construction of different types of structures like bridge piers, abutments, river training and habitat improvement (spurs, vanes, bend-ways, fish-way etc) is of common practice in river engineering since many years. On the contrary, the applicability of such structures would be only significant if the structures serve for the purpose effectively that has been built for. However, the construction of the structures may cause negative environmental consequences on the one hand and the failure of the structure itself on the other.

Of most problems that have been facing in river engineering since long time, the uncontrolled migration is of great significance from practical engineering point of view. It appears that there is still lack of explorative and thorough observation on river migrations as well as planform evolution morphology. Number of physical evidences shows there has been always variation of planforms with the change in boundary conditions. Inadequacy of proper judgments for migrations and estimation for the quality and quantity of the future river planforms is thought to be underlying causes of negative environmental consequences as well as failure of structure. Likewise, construction of such structure is supposed to be economically efficient. Consequently, a reliable methodology for the assessment of the river planform evolution with consideration of the entire sediment composition on flood-plain is of significance in river engineering practice.

Intrinsically, this study can be characterized as an explorative with support from experimental findings and real observations. It has been attempted to quantify the problems associated with river migrations, planform variations in terms of various physical aspects. Furthermore, attempt has been made to bring the solution considering the facts that appear to be overlooked in earlier studies.

The sphere of knowledge that has been considered in this study is the experimental and field study related with river planforms evolutions with consideration of cohesion variation on the one part and the flood-plain strength evolutions, in particular failure strength against erosion, on the other part. Basically, the study was performed, in particular for both parts, making use of extensive physical investigations due to the complication of the phenomenon. The use of various level of cohesion in the sediment mixtures for same level of external boundary conditions helped to understand the whole

range of the phenomenon on the planform evolutions. Similarly, use of flow and depth fluctuation during flood-plain strength measurement would help to compare with natural conditions. The study is essentially performed to establish and discuss the role of cohesion for the judgment of the river migration and evolution towards any patterns with consideration of various bank compositions, viz. non cohesive fine sand, layered flood plain with composition of cohesive and non-cohesive bank as well as single layer with mixture of fine cohesive and non-cohesive materials. To support on the cohesion role description on the planforms, experimental approach has been considered for the assessment of river flood-plain strength characteristics for different bank composition and different boundary conditions. Consequently, study has aimed to be with use of multiple variables such as indirect and direct measurement. Moreover, a basic attempt has been made to determine the hysteresis phenomena on the river channel process with consideration of bank strength on the analogy of discharge and cohesion content, the research on which is scarce.

As far as the part of study on influence of the cohesion on planform evolutions phenomena is concerned, some field evidences have been revealed that corroborate the effect of cohesion or vegetation on the migration of the channel. Furthermore, the four process cyclic phenomena has been proposed and discussed based on present experiments combining with the earlier observations. This four process cyclic model has been partially validated with physical data and may be appropriate in decision-making process during assessment of various problems of river engineering practice, viz. bedform process, and migration as well as meander evolutions. Further this model needs fully validated to be extensively used on the future works.

It is noteworthy to be mentioned that a database has been created collecting the widespread laboratories and field investigations in order to make up a deficiency being encountered by the academic community involved in the subject matter concerning role of cohesion influences on the river planforms evolutions process.

学位論文審査の要旨

主　査　教　授　清　水　康　行
副　査　教　授　泉　　典　洋
副　査　准教授　木　村　一　郎

学位論文題名

ROLE OF COHESIVE SEDIMENT ON THE RIVER CHANNEL DEVELOPMENT

(河道形成における粘着性土質の役割)

河川改修や河川再生管理技術, および河川構造物と水理学的, 河川形態学的相互作用の評価は, 今まで多くの研究が行われてきたにもかかわらず, 技術者にとって今なお興味深い分野である. 様々な形式の橋脚, 橋台, 河川改修, および河川環境改善工法 (水制, ベーン工, 湾曲部, 魚道など) などがかねてから行われ, 一般に広くいきわたっている. 一方で, 個々の河川構造物は, その本来の目的の達成のみが注目されている. しかしながら, 構造物の建設は環境への悪影響を引き起こす要因になりえるばかりでなく, 構造自体の破壊が問題となるなど, 河川への悪影響が懸念される.

実際的観点から, 河川工学が長い間直面し続けてきた最も大きな問題は, 河道形態変動である. 平面河道形態や河床形状の変動については, 観測や実験的研究は十分ではなく, 未解明な部分が多い. 多くの実例から, 河床形状の変動は境界条件に依存することが示されている. 将来にわたる定性的, 定量的な河道平面形状の変遷の予測の欠如は, 河川環境の悪化や河道構造物の崩壊などの悪影響をまねきかねない. ひいては, 河川構造物の 経済的な設計にも悪影響を及ぼす. しかるに, 氾濫原を含めた包括的な流砂挙動を反映させた河道平面形状予測のための信頼できる手法の確立が極めて重要な課題となっている.

本研究は実験的, あるいは現地観測的な研究手法によって特徴づけられる. 河床の変遷や河川平面形状の変化は様々な物理的な側面を考慮しつつ定量化が行われている. さらに, 過去の研究では見過ごされてきたいくつかの要素についてもその解明への試みがなされている.

本研究で実施したのは河川平面形状に関する室内実験, および現地調査であり, 特に, 河床材料の粘性の効果, および浸食に対する河岸の強度に着目している. 基本的に, 現象の解明に向けて, 物理的側面の検討に重点を置いており, この観点からの実験, および現地調査を行っている. 河道平面形状の変化について広く理解するために, 同じ境界条件のもとで粘性が種々異なる材料を用いて検討を実施する. 同様に, 自然に近い状態で河道の強度を検討するため, 流速や水深を周期的に変化させた状態での実験を実施している. 検討は粘性が河床形態に及ぼす働きを解明するものであり, さまざまな護岸の構成, すなわち, 非粘性の細砂による構成, 粘性と非粘性材料による層状の河道構成, 単層粘性, 非粘性材料による構成などについて実験を行い, 比較検討を行う. また, 直接的, 間接的な多数の物理変数を考慮に入れた検討を進めている. さらには, 河道変動や河岸強度に及ぶす流量や粘性

度の履歴現象について言及しているが, これらについては既往の知見の極めて少ない分野といえる. 粘性が河川平面形状に及ぼす影響については, いくつかの現地調査結果により粘性と植生による相互作用が重要であることが確認された. さらには,4 つのステージからなる周期的な現象が, 過去の観測と実験結果の比較を通じて提案された. この 4 ステージの周期モデルは, 部分的には物理的データにより検証され, 河川工学上, 特に, 河床変動, 湾曲の発達などのメカニズムの予測について適用可能であることが示唆された. ただし, このモデルについてはさらに十分な検証が必要である.

粘性土の河川形状変化に対して関心を持つ研究者や研究機関が, 直面している問題を解決すべくデータを収集, 総合していくことが重要であるといえよう.

これを要するに, 著者は河道形成における粘着性土質の役割に関する新知見を得たものであり, 今後の河川工学に貢献するところ大なるものがある. よって著者は, 北海道大学 (工学) の学位を授与される資格あるものと認める.