Hydraulics Research
Wallingford

COHESIVE SEDIMENT RESEARCH

A database of projects in the UK, Belgium, France and Japan

Report SR 233
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CONTRACT

This report describes work funded by Hydraulics Research and by the Department of the Environment under Research Contract PECD 7/6/110 for which the DoE nominated officer was Dr R P Thorogood. It is published on behalf of the Department of the Environment, but any opinions in this report are not necessarily those of the Department of the Environment. The report was produced by Dr E A Delo in the Tidal Engineering Department, under the management of Mr M F C Thorn.

ABSTRACT

Hydraulics Research (HR) and the Department of the Environment (DoE) have jointly funded research with the objective of HR collaborating with University and Polytechnic researchers in the field of cohesive sediments.

To ensure that HR were fully aware of on-going and recent past research on cohesive sediments in the UK, a database of projects was collated and published in March 1989 (HR Report SR 217). A request for information of projects was then sent during 1989 to researchers in Belgium, France, USA, Japan and Holland with the assistance of Dr Reg Parker (USA and Japan) and Professor Brian O'Connor (Holland). In addition, the UK researchers were requested to up-date their information in late 1989.

This report comprises the completed questionnaire forms received from researchers in the UK, Belgium, France and Japan together with summary lists of the projects. Unfortunately, no replies were obtained from the USA or Holland.

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
West J R	University of Birmingham	The transport of cohesive sediments in estuaries	SERC	01-Feb-90	01-Jan-92
Falconer	University of Bradford	Mathematical modelling of flow and solute and sediment transport in coastal waters, Estuaries and Rivers	EC/S&T Comm	01-Jan-90	31-Dec-92
Little C	University of Bristol	Algal stabilistion of estuarine sediments	UKAEA	01-Dec-89	01-Jun-91
West J R	University of Birmingham	Solute and sediment transport in the Forth Estuary	MOD	01-Oct-89	30-Sep-92
Odd N V M	Hydraulics Research	Fluid mud in estuaries	ETSU	01-May-89	31-Jan-91
Delo E A	Hydraulics Research	Estuarine sediments - near-bed processes	DoE (CID)	01-Apr-89	31-Mar-92
West J R	University of Birmingham	Long term inter-tidal zone cohesive sediment transport processes	SERC	01-Mar-89	30-Sep-92
T N Burt	Hydraulics Research	Flocculation of cohesive sediment	DoE (CID)	01-Apr-89	31-Mar-92
Odd N V M	Hydraulics Research	A review of methods of extrapolating tidal model predictions to long term siltation effects in estuaries	ETSU	01-Apr-89	31 Mar-90
Sills G C	Oxford University	Consolidation of phosphatic muds	-	01-Jan-89	30-Sep-89
Collins U B	University of Southampton	Various projects as studentships	NERC/Govt of Rep China	1989	1992+
Paterson D M	University of Bristol	Biogenic stabilisation of estuarine tidal flats	Royal Society	01-Dec-88	01-Dec-93
O'Connor B A	Liverpool University	Mud process modelling	SERC/HR	01-Oct-88	30-Sep-90

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
Marsh J	Plymouth Polytechnic	The residence time and cycling of particles within within a turbidity maximum	NERC (Case Studentship)	01-Oct-88	1991
Delo E A	Hydraulics Research	Fluidisation of settled mud by wave action	DoE (CID)	01-Oct-89	31-Mar-92
Ashley R M	Dundee Inst of Tech/ Univ Coll Swansea	The movement of sediment in combined sewers	SERC	01-Oct-88	20-Aug-91
McCave I N	Cambridge University	North East coast cohesive dynamics study (NECCESEDS)	DoE/MAFF	01-Jun-88	30-Apr-91
Hardman T M	University of Reading	Physical chemistry of cohesive sediments	SERC	01-Jan-88	21-Dec-90
Alani S	Plymouth Polytechnic	The strength, density and settling velocity of cohesive flocs	NERC	01-Jan-88	1990
McCabe J	Plymouth Polytechnic	The interaction of suspended cohesive sediments with turbulent flow	NERC	01-Jan-88	1990
Jones T E R	Plymouth Polytechnic	Response of cohesive sediment beds to fluid shear	SERC/HR	01-Nov-87	01-Nov-90
West J R	University of Birmingham	A field study of turbulence in estuaries	-	01-Oct-87	31-Jan-90
West J R	University of Birmingham	Water quality in the Blackwater Estuary	NRA	01-Oct-87	30-Sep-90
West J R	University of Birmingham/ Plymouth Marine Lab	Mechanisms influencing the turbidity maximum in in the Tamar estuary	NERC	01-Oct-87	30-Sep-90
West J R	University of Birmingham	Inter-tidal zone transport processes	STPG	01-Oct-87	30-Sep-90
Webber N B	University of Southampton	Field investigation of siltation	SERC	01-Jul-87	1989
Evans E M	Plymouth Polytechnic	Modelling cohesive sediment transport	WRC	01-May-87	1989

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
Delo E A	Hydraulics Research	Engineering application of academic research in cohesive sediments	DoE (CID)	01-Apr-87	31-Mar-90
Delo E A	Hydraulics Research	Siltation and stability of dredged channels	DoE (CID)	01-Apr-86	31-Mar-88
Odd N V M	Hydraulics Research	Fluid mud processes	DoE (CID)	01-Apr-85	31-Mar-88
Delo E A	Hydraulics Research	Estuarine muds	DoE (CID)	01-Apr-85	31-Mar-88
Sills G C	Oxford University	Properties of surface layers of sediment beds	SERC	01-Mar-85	31-Aug-88
Sills G C	Oxford University	Sediment behaviour in the Irish Sea	DoE/MAFF	01-Oct-83	31-Mar-88

BELGIUM

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
Bosch L van Den	K U Leuven	Consolidation of layered mud	IMDC/ K U Leuven	1988	1990
Toorman E	K U Leuven	F E model for fluid mud flow towards pumping wells	NFWO/ K U Leuven	1988	1990
de Laet P	Waterbouwkundig Laboratorium Borgerhout/ Min of Public Works	Improvement of the efficiency of agitation dredging	Min of Public Works/Haecke & Van der Meerssche/ Dredging Int	01-Jan-86	31-Dec-90
Wens F	Min of Public Works/ State University Ghent	Determination of nautical bottom in muddy areas	Min of Public Works	1984	-
Engels J	Waterbouwkundig Laboratorium Borgerhout/ Min of Public Works	Determination of nautical depth in muddy areas Simulation of mud in model investigations	Min of Public Works	1984	-

FRANCE

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
le Hir P	IFREMER	Mathematical modelling of fluid mud and turbidity maximum in the Loire estuary	IFREMER	1989	1993
Bassoullet P	IFREMER	General study of cohesive sediment processes	IFREMER	1988	1992 ...
le Hir P	IFREMER	Mathematical modelling of cohesive sediment Morlaix estuary	IFREMER	1987	1990
Fritsch D	Laboratoire National d'Hydraulique	Numerical modelling of suspended sediment transport	EDF/STC	01-Jan-86	31-Dec-88

JAPAN

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
Watanabe A	University of Tokyo	Mud transport due to waves and currents	Grant-in-Aid for SR/Min of Education	01-Apr-89	31-Mar-90
Yauchi E	TOA Corporation	The diffusion of a mud lump falling	TOA Corp	01-Apr-88	31-Mar-90
Nakano S	Univ of Tokushima	Interaction between waves and soft mud in a uniform current	Univ of Tokushima/ Grant-in-Aid for SR/Min of Education	01-Apr-88	31-Mar-90
Murakami K	Port & Harbour Research Institute, Min of Transport	Numerical simulation of mud transport	Min of Transport	01-Apr-88	31-Mar-90
Tsuruya H	Port & Harbour Research Institute, Min of Transport	Experiments on erosion of mud beds under the combined action of waves and currents	-	01-Apr-87	31-Mar-90
Yauchi E	TOA Corporation	Sand covering method for seabed mud under waves	TOA Corp	01-Apr-87	31-Mar-91
Yauchi E	TOA Corporation	Mud behaviour and wave damping under progressive waves	TOA Corp	01-Apr-85	31-Mar-88
Murakami K	Port & Harbour Research Institute, Min of Transport	Study on erosion and deposition of fine cohesive sediment in a tidal flow	Min of Transport	01-Apr-85	31-Mar-89
Mimura N	Ibaraki University	Flocculation of clay and natural mud, and floc settling	Min of Education/ Ibaraki Univ	01-Apr-85	31-Mar-87

COHESIVE SEDIMENTS RESEARCH

Investigator	Institution	Title	Sponsor(s)	Start	Finish
Tsuruya H	Port & Harbour Research Institute, Min of Transport	Determination of yield stress of soft muds with vane and slump test	-	01-Apr-85	31-Mar-89
Horie Takeshi	Port & Harbour Research Institute, Min of Transport	Field measurement of settling flux of fine organic particles to bottom inner bay	Japanese Government	01-Apr-84	31-Dec-88
Ashida K	Kyoto University	Erosion and stream formation on a cohesive sediment bed	-	1974	1982

United Kingdom

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
West, J.R.* Delo, E.A.**
Darbyshire, E.J.*

INSTITUTION: *School of Civil Engineering, University of B'ham
**Hydraulics Research Ltd.

TITLE:
The transport of cohesive sediments in estuaries

SPONSOR(S): S.E.R.C.

START DATE: February 1990 **COMPLETION DATE:** January 1992

DESCRIPTION OF PROJECT:

Field measurements of turbulent and turbulence cohesive sediment transport parameters are planned in the Tamar and Parrett estuaries. It is intended that field determined transport parameters should be compared with laboratory determined values in a Carousel flume at Wallingford.

OUTLINE OF PROGRESS UP TO END 1989:

- None -

PUBLICATIONS:

- None -

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
Professor R.A. Falconer

INSTITUTION:
University of Bradford

TITLE: Mathematical Modelling of Flow and Solute and Sediment Transport in Coastal Waters, Estuaries and Rivers

SPONSOR(S): European Community and Science and Technology Commission

START DATE: January 1990 **COMPLETION DATE:** December 1992

DESCRIPTION OF PROJECT: The main objectives of the study are to develop refined mathematical models of flow and solute and sediment transport due to tidal action in coastal and estuarine waters. In connection with the sediment transport aspects of the study, a two-dimensional hydrodynamic model will be linked to a three-dimensional representation of the advective-diffusion equation. The model will be applied to the Humber Estuary (UK) and, in particular, site specific studies in the People's Republic of China.

OUTLINE OF PROGRESS UP TO END 1989:

Nil - Project start date delayed by EC due to recent events in China

PUBLICATIONS:

Nil for this project

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
C Little R M Crawford
D M Paterson

INSTITUTION:
Bristol University
Dept of Biology

TITLE: Algal stabilisation of estuarine sediments

SPONSOR(S): United Kingdom Atomic Energy Authority

START DATE: December 1989 **COMPLETION DATE:** June 1991

DESCRIPTION OF PROJECT:
The aim of the project is to assess the significance of stabilisation of sediments by algae, in relation to the changes in hydrodynamic and sedimentological regimes arising from the construction of tidal power barrages.

OUTLINE OF PROGRESS UP TO END 1989:
Staff recruited and initial training. Staff selected were Dr Graham Underwood and Ms Jenny McArthur

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S): West, J.R.,
Horsington, R.W.,
Lindsay, P.

INSTITUTION: School of Civil Engineering, University of Birmingham.

TITLE:
Solute and sediment transport in the Forth Estuary

SPONSOR(S): M.O.D.

START DATE: October 1989 **COMPLETION DATE:** September 1992

DESCRIPTION OF PROJECT:

A field investigation of solute and fine particulate transport mechanisms in a deep wide estuary will be undertaken with particular reference to short term mixing and adsorption phenomena.

OUTLINE OF PROGRESS UP TO END 1989:

A literature survey and a simple mathematical model are currently being implemented.

PUBLICATIONS:

- None -

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S): Mr N V M Odd
INSTITUTION: Hydraulics Research Ltd

TITLE: Fluid mud in estuaries

SPONSOR(S): Energy Technology Support Unit

START DATE: May 1989 **COMPLETION DATE:** Jan 1991

DESCRIPTION OF PROJECT:
To undertake field, laboratory and mathematical modelling studies to investigate the processes governing the formation, movement and shearing of fluid mud layers in estuaries.

OUTLINE OF PROGRESS UP TO END 1989:
The field survey was designed to obtain detailed information on the formation, movement, shearing and re-suspension of the fluid mud layer in a stretch of the Parrett Estuary, Somerset. Field measurements were carried out over two five five day spring tide periods.

Laboratory studies of fluid mud were conducted to determine the de-watering rate, entrainment rate and rheology of fluid mud pumped up from the Parrett Estuary.

PUBLICATIONS:
Fluid mud in estuaries: Field Measurements 1989. Hydraulics Research Report No EX 2076, January 1990.
Fluid mud in estuaries: Laboratory experiments. Hydraulics Research Report No EX 2085, January 1990.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Dr E A Delo
INSTITUTION: Hydraulics Research Ltd

TITLE: Estuarine sediments : near-bed processes

SPONSOR(S): Department of the Environment (CID) (yet to be approved)
START DATE: April 1989 **COMPLETION DATE:** March 1992

DESCRIPTION OF PROJECT:
To measure in the field the near-bed processes associated with cohesive sediment transport in an estuarine environment.
To determine in the laboratory the mud properties and to simulate its behaviour during tidal cycles.
To refine and calibrate the cohesive sediment algorithms used in predictive computer models.

OUTLINE OF PROGRESS UP TO END 1988:
This project is yet to be approved by DoE.

PUBLICATIONS:
None to date.

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S): West, J.R.*
Sokhi, R.S.** Randle, K.**
Beresford Hartwell, P.R.*

INSTITUTION: *School of Civil Engineering; **School of Physics & Space Research, University of B'ham

TITLE:
Long term inter-tidal zone cohesive sediment transport processes

SPONSOR(S): S.E.R.C

START DATE: March 1989 **COMPLETION DATE:** September 1992

DESCRIPTION OF PROJECT:

Field measurements are planned in order to determine the mechanisms which control the long term erosion and accretion of fine sediments on estuarine inter-tidal zones and salt marshes. Chronological studies will include the use of radionuclide, heavy metal, mineralogical and sediment parameter measurements.

OUTLINE OF PROGRESS UP TO END 1989:

Preliminary studies have been made on the Severn, Blackwater and Ribble estuaries. Initial results based on PIXE analysis for heavy metals and γ radiation counting for radionuclides show that net deposition rates can be determined over the time scale of decades and some correlation with sediment properties has been found. Some initial effort on model development has been made.

PUBLICATIONS:

SOKHI, R.S. et al, (1989) 'Heavy metals and radio-nuclides in estuarine sediments', Proc.Int.Conf.Heavy Metals in the Environment, Geneva, Vol.1, pp.530-533.

SOKHI, R.S. et al (1990), 'Elemental analysis of sediments from the Severn estuary', Nuclear Instruments and Methods (in press).

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S):
Dr E A Delo

INSTITUTION:
Hydraulics Research Ltd

TITLE: Estuarine sediments: Near-bed processes

OUTLINE OF PROGRESS UP TO END 1989:

A pilot study at two positions within Harwich Harbour during spring and neap tides has been undertaken from a survey boat to measure the through-depth velocities and suspended sediment concentrations. A bed-mounted frame which supports a comprehensive array of instruments linked to a microcomputer for logging and analysis has been developed to measure the hydrodynamics, suspended sediment concentrations and bed elevations. Pilot deployment of this frame will take place in the next two months.

Laboratory tests on samples of mud from Harwich Harbour were conducted by HR in December 1988. Accordingly, these results will be used in the interpretation of field data on the near-bed processes from Harwich.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Mr T N Burt

INSTITUTION:
Hydraulics Research Ltd

TITLE: Flocculation of cohesive sediment

SPONSOR(S): Department of the Environment (CID) (yet to be approved)
START DATE: April 1989 COMPLETION DATE: March 1992

DESCRIPTION OF PROJECT:
To investigate the factors controlling the formation and size of mud flocs in estuaries. To investigate instrumentation for measuring floc size in both the laboratory and field. To correlate field and laboratory floc settling velocities. To investigate the validity of applying a differential settling correction to field settling velocity measurements. To investigate the effect of turbulence on floc size by experiment in the HR mud carousel.

OUTLINE OF PROGRESS UP TO END 1988:
This project is yet to be approved by DoE.

PUBLICATIONS:
None.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S):
Mr T N Burt
Mr M P Dearnaley

INSTITUTION:
Hydraulics Research Ltd

TITLE: Flocculation of cohesive sediment

OUTLINE OF PROGRESS UP TO END 1989:
This project started in November 1989. Preliminary experiments using a monochrome video camera to simultaneously measure floc size and settling velocity in a settling column have been carried out and a resolution of 10-20 microns has been achieved. The settling column is to be incorporated into the base of the HR carousel flume.

PUBLICATIONS:
None to date.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Mr N V M Odd

INSTITUTION: Hydraulics Research Ltd

TITLE: A review of methods of extrapolating tidal model predictions to long term siltation effects in estuaries.

SPONSOR(S): ETSU (approved in principle)

START DATE: April 1989 **COMPLETION DATE:** March 1990

DESCRIPTION OF PROJECT:
To review past and existing methods of predicting the effect of engineering works on long term siltation and erosion patterns in estuaries. In particular the extrapolation of results from tidal mathematical models.

OUTLINE OF PROGRESS UP TO END 1988:
This project is due to start in April 1989.

PUBLICATIONS:
None.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): G. C. Sills

INSTITUTION: Oxford University Engineering Department

TITLE:
Consolidation of phosphatic muds

SPONSOR(S):

START DATE: January 1989 **COMPLETION DATE:** September 1989

DESCRIPTION OF PROJECT:

Laboratory-based study of settlement and consolidation behaviour of a mud produced as waste during mining operations in Brazil.

OUTLINE OF PROGRESS UP TO END 1988:

None

PUBLICATIONS:

None

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S): DR M B COLLINS

INSTITUTION: DEPARTMENT OF OCEANOGRAPHY, UNIVERSITY OF SOUTHAMPTON

TITLE: VARIOUS PROJECTS (SEE BELOW), AS STUDENTSHIPS

SPONSOR(S): (See Below)

START DATE: 1989 COMPLETION DATE: 1992+

DESCRIPTION OF PROJECT:

1. The in-situ determination of erodibility, using a field flume (NERC)
2. The stability of tidal inlets (Government, Peoples Republic of China)
3. Regional patterns of fine-grained sediment movement, South Coast of England
4. Laboratory determinations of the threshold of mud/sand admixtures

OUTLINE OF PROGRESS UP TO END 1989:

1. Literature review
2. Inshore and offshore sediment sampling: some field observations of currents etc
3. Literature review, initial laboratory measurements
4. Initial laboratory testing completed - trends identified

PUBLICATIONS:

4. In preparation

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): David M Paterson

INSTITUTION: University of Bristol

TITLE: Biogenic stabilisation of estuarine sediments

OUTLINE OF PROGRESS UP TO END 1989: The effect of diatom assemblages on the erodibility of intertidal, cohesive, estuarine sediments is underway. A novel technique (CSM) to measure the relative stability of cohesive sediments in situ has been developed. The CSM has demonstrated cylic changes in sediment stability over the period of a tidal cycle. During emersion maximum stability depends on the relative position of the site within the intertidal. Stability was greatest at sites that also had high population densities of epipelic diatoms. The CSM was used as part of the Canadian LISP programme (Littoral Investigation of Sediment Processes), Bay of Fundy. Results from this programme are being collated with other investigators and will be available in 1990.

PUBLICATIONS:

Paterson DM, 1989 Short-term changes in the erodibility of intertidal cohesive sediments related to the migratory behaviour of epipelic diatoms. Linnol Oceanogr. 34(1) 223-234.

Paterson DM, Crawford RM & Little C. Sub-aerial exposure and changes in the stability of Intertidal Estuarine sediments. Estuarine, Coastal & Shelf Sci. (In the press)

Paterson DM, The influence of epipelic diatoms on the erodibility of an artificial sediment. Proc 10th Int Synp Living & Fossil Dialom 1988 (In the press)

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Dr D M Paterson, Dr C Little, Dr R M Crawford

INSTITUTION: University of Bristol

TITLE: Biogenic Stabilisation of Estuarine Tidal Flats

SPONSOR(S): Royal Society

START DATE: 1.12.88 **COMPLETION DATE:** Provisionally 1.12.93

DESCRIPTION OF PROJECT:

Examining the relationship between microbial communities and the surface cohesive strength of inter-tidal cohesive sediments over diurnal monthly and annual cycles.

OUTLINE OF PROGRESS UP TO END 1988:

Mainly development of techniques for measurement of sediment stability and the examination of sediments frozen in situ to provide an accurate visualisation of surface sediment communities.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Prof. B A O'Connor, Dr. K H M Ali

INSTITUTION: Liverpool University

TITLE: Mud process modelling

SPONSOR(S): SERC / HRL

START DATE: October 1988 **COMPLETION DATE:** September 1990

DESCRIPTION OF PROJECT:
To contact existing researchers in order to provide information for the updating of the existing models and guidance for the future laboratory and field research. To start updating and testing the existing models.

OUTLINE OF PROGRESS UP TO END 1988:
The carrying out of laboratory tests on fluid mud processes at Hydraulics Research in connection with the updating of the existing models.

PUBLICATIONS: Relevant publications connected with research -
Nicholson and O'Connor, "Cohesive Sediment Transport Model", Jour. Hydr. Engrg., Vol 112, No 7, July 1986.
O'Connor and Nicholson, "Mud transport modelling", Physical Processes in Estuaries, Dronkers and van Leussen (eds.), Springer-Verlag, Berlin, 1988.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S):
PROF. B.A. O'CONNOR
DR. K. H. M. ALI

INSTITUTION:
UNIVERSITY OF LIVERPOOL

TITLE:
MUD PROCESS MODELLING

OUTLINE OF PROGRESS UP TO END 1989:

Cohesive sediment researchers have been contacted, to determine the nature and scope of current research, in collaboration with H.R. Ltd. Further, more detailed discussions have taken place with specific researchers to ascertain how the different processes under investigation can usefully be incorporated into system models being improved at Liverpool. The time-scale associated with this and the identification of areas where future research could fruitfully be concentrated have also been discussed.

Field and laboratory studies also in collaboration with H.R. Ltd. have also taken place. Use of laboratory facilities at H.R. enabled a, largely qualitative, study to be made of the fluid phenomenon. The experiments examined various suspensions of Grangemouth mud settling onto differing bed slopes, and revealed two mechanisms for the down-slope movement of mud.†

Field measurement of all necessary parameters was conducted in the vicinity of the dock entrance to Grangemouth Harbour in collaboration with the Forth Ports Authority and H.R. These measurements not only provided a data base against which the revised system model can be tested, but also an insight into the behaviour of the area in comparison with earlier surveys. Work has also begun on the revision and updating of a three-dimensional cohesive sediment transport model to include the latest findings of research into the various processes involved.

PUBLICATIONS:

1. "The behaviour of mud suspensions as they settle on to a sloping bed: an experimental investigation".
   Dept. of Civil Engineering, University of Liverpool. Internal Report.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): J. MARSH
(Professor K.R. Dyer and
Dr. A.J. Bale - Supervisors)

INSTITUTION:
Institute of Marine Studies
Plymouth Polytechnic

TITLE: "The residence time and cycling of particles within a turbidity maximum"

SPONSOR(S): NERC (Case studentship)

START DATE: October 1988 **COMPLETION DATE:** 1991

DESCRIPTION OF PROJECT: Techniques are being developed to label estuarine particles with fluorescent tracer. Labelled particles will then be released at various places within the turbidity maximum, and detected using a flow cytometer. From the results the residence time of particles within the turbidity maximum can be calculated, as well as the timescales involved in the exchange of cohensive sediment between the bed and suspension.

OUTLINE OF PROGRESS UP TO END 1988: A preliminary literature survey has been completed. Initial experiments with the flow cytometer have shown the detectability limits, and sampling errors that have to be taken into account when designing field experiments.

PUBLICATIONS: None to date.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): J. Marsh (Professor K.R. Dyer and Dr. A.J. Bale, Supervisors)

INSTITUTION: Institute of Marine Studies, Polytechnic South West, Plymouth

TITLE: "The Residence Time and Cycle of Particles Within a Turbidity Maximum". SPONSOR: NERC (Case Studentship)

START DATE: October 1988 COMPLETION DATE: 1991

OUTLINE OF PROGRESS UP TO END 1989:

DESCRIPTION OF PROJECT: Techniques are being developed to label estuarine particles with fluorescent tracer. Labelled particles will then be released at various places within the turbidity maximum, and detected using a flow cytometer. From the results the residence time of particles within the turbidity maximum can be calculated, as well as the time scales involved in the exchange of cohesive sediments between the bed and suspension.

OUTLINE OF PROGRESS TO THE END OF 1989: Attempts to coat natural particles with fluorescent dye have been unsuccessful. Fine resin particles incorporating a fluorescent dye, however, have been located. These have been used successfully in a settling pond in an experiment designed to investigate the detectability of the particles in a matrix of natural particles, as well as the natural turbulent dispersion. It is anticipated that experiments will be carried out in the summer of 1990 in the Tamar estuary.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Dr E A Delo

INSTITUTION: Hydraulics Research Ltd

TITLE: Fluidisation of settled mud by wave action

SPONSOR(S): Department of the Environment (CID)

START DATE: October 1988 **COMPLETION DATE:** March 1992

DESCRIPTION OF PROJECT:
To design and construct a stable platform and field instrumentation to measure the generation of fluid mud in the field. To construct a natural wave generator for an existing flume and conduct tests on mud beds under natural waves. To develop theory to describe the fluidisation process and incorporate it into numerical models. To communicate the findings of the research to industry through a working manual.

OUTLINE OF PROGRESS UP TO END 1988:
The project has run for three months. A natural wave generator has been designed and construction has commenced. Some preliminary tests on beds under mono frequency waves have been conducted to develop new measurement techniques. These include the in-situ measurement of the density of the mud bed during a test and the accurate measurement of surface vertical deflections of the mud bed under the passage of the wave.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): Dr E A Delo

INSTITUTION: Hydraulics Research Ltd

TITLE: Fluidisation of settled mud by wave action

OUTLINE OF PROGRESS UP TO END 1989:

To measure the erosion of mud from inter-tidal mudflats, an array of field measuring instruments have been mounted on a small bed frame with cables linking to a computer logging station on dry land. The design of the instrument package is complete and pilot measurements have been successful. The changes in the mudflats were also monitored by two observation visits per week for more than two months. This has provided valuable data on the controlling factors of erosion and deposition of mud at the site.

A random wave generator for the existing mono-frequency wave flume has been designed, constructed and installed. Tests have been conducted under mono-frequency waves in order to develop new measuring techniques for monitoring the bed. Instrumentation has been deployed to measure the dynamic vertical surface deflection of the mud bed and the in-situ density structure of the bed during a test. A standard laboratory testing procedure has been developed for mono-frequency waves and tests have commenced using random waves. Consideration has been given to the theoretical analysis of mud erosion by waves.

PUBLICATIONS:

Erosion of mud by waves: Development of a field measurement system. Report SR 225, January 1990 (in final draft)

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):	**INSTITUTION:**
Mr R M Ashley	Dept of Civil Engng, Surveying & Bldg, Dundee Inst of Technol
Mr I Longmuir	Dept of Electronic & Elec Engng, Dundee Inst of Technol
Dr D J A Williams	Dept of Chem Engng, Univ Coll, Swansea

TITLE:
The movement of sediment in combined sewers

SPONSOR(S): SERC

START DATE: 01.10.88 **COMPLETION DATE:** 29.09.91

DESCRIPTION OF PROJECT:
To increase understanding about the nature and behaviour of cohesive sediments in sewers. To develop improved models for the origin, nature, deposition and re-entrainment of sediments in combined sewers. To develop numerical models for the behaviour of sediments in combined sewers.

OUTLINE OF PROGRESS UP TO END 1989: (University College of Swansea)
An in-situ rheometer which incorporates transducers based upon piezoceramic-driven plates has been designed and tested in the laboratory for -he generation and detection of shear waves in sediments. The design which also incorporates a facility to detect dynamic pressure changes within a sediment bed, obviates many of the drawbacks associated with established methods of shear wave generation. These include the generation of extraneous (compressional) wave energy and impedance mismatch. Synthetic sediments involving sand/clay mixtures which reproduce the elastico-viscous behaviour of cohesive sewer sediments have been used in these tests. The rheometer has been successfully tested in a test length of a Dundee sewer.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S): **INSTITUTION:**

Mr R M Ashley — Dept of Civil Eng, Surv & Bldg, Dundee Institute of
Mr I Longair — Dept of Electronic & Elect Eng, Technology
Dr D J A Williams — Dept of Chem Eng, University College, Swansea

TITLE: The Movement of Sediment in Combined Sewers

SPONSOR(S): SERC

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OUTLINE OF PROGRESS UP TO END 1989: (Dundee Institute of Technology)
A review of the data collected over the last 2 years in the main sewer length relating to sewer sediments and their movements has been made. Whilst providing background information, the measurement techniques used were not precise enough for these data to be of direct relevance to the cohesive sediment studies. Various velocity measurement systems have been tested in the laboratory and in the sewer in an attempt to refine the field determination of velocity gradients near to the sediment bed. Currently an array system using eight ultrasonic velocity sensors is being appraised and software developed to measure velocity distributions in conjunction with Detectronics Ltd.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): **INSTITUTION**

P.I. Professor I.N. McCave, — Dept. of Earth Sciences,
Mr. T.R.E. Owen, Dr. M.O. Green, — Cambridge University.

Dr. C. E. Vincent, — School of Environmental Sciences,
Dr. A.E. James — University of East Anglia.

Dr. R. R. Dickson & staff — MAFF Fisheries Lab., Lowestoft

TITLE
North East Coast Cohesive Sediment Dynamics Study (NECCESEDS)

SPONSOR(S): DOE and MAFF

START DATE: 1st June, 1988 **COMPLETION DATE:** 30th April 1991

DESCRIPTION OF PROJECT:

Field study of wave-current interaction and resulting stresses and sediment resuspension over sandy mud beds in the near shore region between the Tyne and the Tees. Study of the mechanical properties of the sediment, their geochemistry and radiochemistry in order to assess contaminant loadings and rates of accumulation and bioturbation. Study of the hydrography of the region and the dispersal of fine suspended sediment trapped inshore of the Flamborough Front. Development of new instrumentation for study of the wave-current boundary layer, bed roughness and sediment setting velocity distribution.

OUTLINE OF PROGRESS UP TO END 1988:

Site selection: areas between Tyne and Tees surveyed and sampled to find area of mud bed in water shallower than 30 m where wave action will be great in storms.
Trial deployment of MAFF tetrapod with e.m. and pressure sensors and 0.25 m transmisometer over 25 hour periods. Data have been used to examine structure-flow interferences, sensor performance and spectral characteristics of flow with and without wave action.
Trial deployments of new settling tube (redesign of Owen tube), the QUISSET (Quasi in situ settling tube). Median settling velocity is 6×10^{-3} mm/s with a modal value of 7×10^{-2} mm/s.
Grant-Madsen-Glen (GMG) model for the sediment stratified wave-current boundary layer set up and numerical experiments run on conditions likely to be encountered off N.E. coast.
Models of spectral windows for Reynolds Stress estimation in sediment stratified flows investigated to provide guidance in instrument and experimental design. We will be measuring stress both from u'w' and dissipation-region data.

PUBLICATIONS:

No publications yet

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): T.M.HARDMAN, J.C.WATTS.

INSTITUTION: CHEMISTRY DEPARTMENT, UNIVERSITY OF READING.

TITLE: PHYSICAL CHEMISTRY OF COHESIVE SEDIMENTS.

SPONSOR(S): SERC

START DATE: 1.1.88. **COMPLETION DATE:** 31.12.90.

DESCRIPTION OF PROJECT:

Study of the surface chemistry, flocculation sedimentation and rheology of cohesive sediments.

OUTLINE OF PROGRESS UP TO END 1988:

Characterisation and rheological properties of natural and synthetic (model) river sediments. Flocculation studes effect of shear.

PUBLICATIONS:

None so far.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S):
T.M. Hardman
J.C. Watts.

INSTITUTION:
Chemistry Department
University of Reading

TITLE:
Physical Chemistry of Cohesive Sediments.

OUTLINE OF PROGRESS UP TO END 1989:

Characterisation and rheological properties of natural and synthetic (model) river sediments. Determination of the charge/pH isotherms of substrates and of added polyelectrolytes as a function of ionic strength. Studies of floc size and kinetics of flocculation Rheological measurements of dispersion and flocculated dispersions under various defined conditions; time dependence of the bulk properties.

PUBLICATIONS:

Not yet submitted.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Dr. S. ALANI

INSTITUTION:
Institute of Marine Studies
Plymouth Polytechnic

TITLE: "The strength, density and settling velocity of cohesive flocs"

SPONSOR(S): NERC.

START DATE: January 1988 **COMPLETION DATE:** 1990

DESCRIPTION OF PROJECT: Laboratory measurements are being carried out of the interaction between natural flocs, and a turbulent field of known intensity. These are being carried out within a laboratory mixing chamber by visulisation techniques. The relationship between the floc break-up and the turbulent energies can be calculated, together with the floc sizes and settling velocities. Comparison will be carried out with field measurements.

OUTLINE OF PROGRESS UP TO END 1988: A series of measurements have been carried out relating the strength and density of flocs to salinity. Measurements are planned on a series of samples taken from a longitudinal section through the turbidity maximum in the Tamar Estuary.

PUBLICATIONS: None to date.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S):
Dr. S. Alani

INSTITUTION:
Institute of Marine Studies,
Polytechnic South West, Plymouth

TITLE: "The Strength, Density and Settling Velocity of Cohesive Flocs". SPONSOR: NERC

START DATE: January 1988 COMPLETION DATE: 1990

OUTLINE OF PROGRESS UP TO END 1989:
DESCRIPTION OF PROJECT: Laboratory measurements are being carried out on the interaction between natural flocs and a turbulent field of known intensity. These are being carried out within the laboratory mixing chamber by visualization techniques. The relationship between the floc break-up and the turbulent energies can be calculated, together with the floc sizes and settling velocities. Comparison will be carried out with field measurements.

OUTLINE OF PROGRESS UP TO THE END OF '89: A series of measurements have been carried out relating the strength and density of flocs to salinity and to suspended particle concentration. The results have shown that there is a maximum in the floc strength and in floc density at a salinity of about 10-15 parts per thousand. This occurs at all particle concentrations. Additionally analysis has shown that there is a time response in the floc-turbulent interaction.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): J. McCABE (Professor K.R. Dyer and Professor D.A. Huntley - Supervisors)

INSTITUTION: Institute of Marine Studies Plymouth Polytechnic

TITLE: "The interaction of suspended cohensive sediments with turbulent flow"

SPONSOR(S): NERC. Collaborative with Plymouth Marine Lab.

START DATE: January 1988 **COMPLETION DATE:** 1990

DESCRIPTION OF PROJECT:

Measurements of the relationship between floc size, density, and settling velocity with turbulent parameters, such as turbulent kinetic energy, and concentration. Comparison with laboratory measurements, and interpretation in the light of analytical theory. Parameterisation of the results for inclusion into estuarine models.

OUTLINE OF PROGRESS UP TO END 1988:

A field experiment was carried out in the Tamar Estuary during which a Malvern particle size analyser was deployed in-situ to measure the floc size and size distribution, together with two EM flow meters measuring the turbulent characteristics. Optical backscatter sensors were used to measure the concentration field. Analysis of the results is progressing, with presentation in terms of spectra, turbulence parameters and stratification, for comparison with the floc size data.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): J. McCabe (Professors K.R. Dyer and D.A. Huntley, Supervisors)

INSTITUTION: Institute of Marine Studies Polytechnic South West, Plymouth

TITLE: "The Interaction of Suspended Cohesive Sediments with Turbulent Flow". SPONSORS: NERC collaborative with Plymouth Marine Laboratory.

START DATE: January 1988. COMPLETION DATE: 1990

OUTLINE OF PROGRESS UP TO END 1989:

DESCRIPTION OF PROJECT: Measurements of the relationship between floc size, density, settling velocity with turbulent parameters, such as turbulent kinetic energy, and concentration. Comparison with laboratory measurements, and interpretation in the light of analytical theory. Parameterization of the results for inclusion into new estuarine models.

OUTLINE OF PROGRESS: 2 field experiments have been carried out in the Tamar estuary during which a Malvern Particle Size Analyser was deployed in-situ to measure the floc size and size distribution, together with two EM flow meters measuring the turbulent characteristics. Optical backscatter sensors were used to measure the concentration field. Measurements were carried out over several tidal cycles, and throughout the turbidity maximum. The results indicated that there was a decrease of floc size within the turbidity maximum, compared with outside. This coincided with high values of the turbulent dissipation rates. Further analysis will consider the spectral information in velocity and concentration.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): Dr. T. E. R. Jones
Dr. P. W. James, Dr. J. M. Davies
Dr. D. I. Graham

INSTITUTION: Polytechnic South West

TITLE:
Response of Cohesive Sediments Beds to Fluid shear

OUTLINE OF PROGRESS UP TO END 1989:

A comprehenisve theoretical study of the turbulent flow of water in the H.R. Carousel has been carried out for a range of flow parameters and turbulence models. The results obtained show excellent agreement with existing experimental data and are insensitive to the particular turbulence model used (e.g. k-e, mixing-length, algebraic stress, Reynolds stress). A full calibration of the shear stress probes has been carried out at Plymouth and H.R. using the rig which was specifically designed and constructed for the H.R. Carousel. The probes have been installed in a test section fitted to the H.R. Carousel and results obtained for both side-wall and bed shear stress. The measurements and predictions of both (i) the direction of maximum bed shear stress and (ii) shear stress profiles are in very good agreement. A great deal of confidence can therefore be placed in the numerical method for predicting bed shear stress.

A complete rheological study has been performed on River Parrett muds of varying concentrations. The data obtained will be used in conjunction with the numerical model to predict critical shear stresses, initially in the H.R. Carousel and eventually in real estuarine situations.

PUBLICATIONS:

Graham D. I. "Numerical modelling of turbulent water flow in the Hydraulics Research Carousel Flume." Polytechnic South West Research Report MSOR-89-04 (1989)

Graham D. I. "Numerical evaluation of wall shear stresses in the Hydraulics Research Carousel Flume." Polytechnic South West Research Report MSOR-89-09

Graham D. I. "Numerical investigation into geometric modification of the Hydraulics Research Carousel Flume." Polytechnic South West Research Report MSOR-89-10

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr.T.E.R.Jones

INSTITUTION:
PLYMOUTH POLYTECHNIC

TITLE:
Responce of cohesive sediment beds to fluid shear

SPONSOR(S): S.E.R.C & H.R.L.

START DATE: 1/11/87 **COMPLETION DATE:** 1/11/90

DESCRIPTION OF PROJECT:
This project will be concerned with a theoretical and experimental study of the flow behaviour of cohesive sediments. The proposed theory will enable more accurate predictions to be made of critical stress levels in the H.R.flume and hence in real estuarine flow situations.The controlled stress and circular flume experimental program will produce a characterization of cohesive sediments which will lead to an improved understanding of the flow mechanisms

OUTLINE OF PROGRESS UP TO END 1988:
Preliminary flow experiments have been carried out to determine the low shear properties of test cohesive sediments.A calibration rig has been constructed to test shear stress probes which will be inserted in the test section at H.R.L. in the near future.The theoretical program of work,to characterize the turbulent flow of water in the Carousel,was started in September 1988 and obviously is at a very early stage.However preliminary results are encouraging and predict the primary flow quite accurately

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
West, J.R., Darbyshire, E.J.

INSTITUTION: School of Civil Engineering, University of Birmingham

TITLE:
A field study of turbulence in estuaries

SPONSOR(S):

START DATE: October 1987 **COMPLETION DATE:** January 1990

DESCRIPTION OF PROJECT:

Field measurements of turbulent fluctuations of velocity, salinity and suspended solids have been undertaken in the Tamar estuary. Measurements have been made simultaneously at four points in the water column. The objective of the study is to investigate the relative importance of bed generated turbulence and internal waves with respect to momentum, salinity and cohesive sediment transport.

OUTLINE OF PROGRESS UP TO END 1989:

Measurements have been undertaken during four tidal cycles. The results show significant differences on flood and ebb tides due to the interaction of shear and the longitudinal density gradient. Internal wave effects probably have a significant influence on vertical transport processes. The vertical transport of cohesive sediments is a complex function of space and time.

PUBLICATIONS:

DARBYSHIRE, E.J. and WEST, J.R., (1989), 'Spatial and temporal turbulence characteristics in the Tamar estuary, Proc.ECSA19 Symp., Estuaries and Coasts, Caen, France (in press).

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
West. J.R., Horsington, R.W., Calverley, M.J.

INSTITUTION: School of Civil Engineering, University of Birmingham.

TITLE:
Water quality in the Blackwater Estuary

SPONSOR(S): National Rivers Authority

START DATE: October 1987 **COMPLETION DATE:** September 1990

DESCRIPTION OF PROJECT:

Field measurements of hydrodynamics, cohesive sediment transport and water quality have been made in the Blackwater estuary. The basic transport processes are being modelled in a one dimensional time dependent model.

OUTLINE OF PROGRESS UP TO END 1989:

The field data are being analysed to determine the mechanisms which affect suspended sediment transport during summer periods and the influence of fine sediments on biochemical oxygen demand.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
West, J.R.,* Uncles, R.J.**, Barton, M.L.*

INSTITUTION: *School of Civil Engineering, University of B'ham
** Plymouth Marine Laboratory

TITLE:
Mechanisms influencing the turbidity maximum in the Tamar estuary

SPONSOR(S): N.E.R.C.

START DATE: October 1987 **COMPLETION DATE:** September 1990

DESCRIPTION OF PROJECT:

Field measurements of cohesive sediment fall velocity and turbulent mean velocity, salinity and suspended solids concentration have been undertaken in the Tamar estuary. The turbulent mean data have been collected from continuous recording equipment for periods of fourteen days.

OUTLINE OF PROGRESS UP TO END 1989:

The fall velocity data show that the suspension characteristics undergo a seasonal change. The turbulent mean data are being analysed to determine the variation of longitudinal sediment fluxes with river discharge, tidal range and vertical density gradients.

PUBLICATIONS:

BARTON, M.L. et al (1989), 'Particle fall velocities and related variables in the Tamar estuary. Proc. ECSA 19 Symp., Estuaries and Coasts, Caen, France (in press).

COHESIVE SEDIMENTS RESEARCH - NEW PROJECTS

INVESTIGATOR(S):
West, J.R., Coates, L.E., Horsington, R.W. West, M.S.

INSTITUTION: School of Civil Engineering, University of Birmingham

TITLE:
Inter-tidal zone transport processes

SPONSOR(S): Severn Tidal Power Group

START DATE: October 1987 **COMPLETION DATE:** September 1990

DESCRIPTION OF PROJECT:

Field measurements of inter-tidal zone cohesive sediment dynamics have been made at up to eight sites over a period of two years in order to determine sediment transport rates and sediment characteristics as a function of time and space. Determination of wave energy and shear stress have been made from field measurements.

OUTLINE OF PROGRESS UP TO END 1989:

The data have shown that storm induced waves and river flow have significant effects on erosion and accretion rates and the vertical density profiles in cohesive sediments. A mathematical model is being used to determine the relative importance of the underlying mechanisms.

PUBLICATIONS:

WEST, M.S. and WEST, J.R., (1989), 'Spatial and temporal variations in inter-tidal zone sediment properties in the Severn estuary', UK.,Proc.ECSA 19 Symp., Estuaries and Coasts, Caen, France (in press).

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): N. B. WEBBER, DR. P. TOSSWELL
INSTITUTION: DEPT. OF CIVIL ENGINEERING, UNIVERSITY OF SOUTHAMPTON

TITLE: Field investigation of siltation

SPONSOR(S): SERC

START DATE: JULY 1987 **COMPLETION DATE:** 1989

DESCRIPTION OF PROJECT: A silt monitoring rig was developed and installed in a quiescent berth at Port Hamble Marina. It was equipped with electro-magnetic current meters, suspended solids monitors and a temperature/salinity sensor. Recording was over a period of 17 months. Sediment traps were also installed and separately monitored.

OUTLINE OF PROGRESS UP TO END 1988: All the instruments performed well except the suspended solids monitors, in spite of prodigious efforts to modify and further develop them. Calibration drift was attributed to lens contamination - a serious problem in such low background concentrations (50mg/l).
Field results from cylindrical sediment traps have been encouraging. Their performance has been investigated in a large laboratory flume.
Overall, the research indicates strong correlation between silt suspension and tidal range, with higher concentrations (up to 200mg/l)being mainly associated with storm surges.
Two Ph.D. theses (mathematical modelling and sediment traps) are being finalised.

PUBLICATIONS:
P. Tosswell and N.B. Webber, 'The Development of a Silt Monitoring Rig', Proc.Int.Conf. on Measuring Techniques of Hydraulics Phenomena,BHRA,1986.
P. Tosswell and N.B. Webber,'Siltation in Marinas; The Case History of Port Hamble', Paper to be presented at Int.Conf.: Marina '89.
J. White, 'The Use of Sediment Traps to Monitor Marina Siltation',Paper to be presented at Int.Conf.: Marina '89.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Dr. E.M. EVANS and Professor K.R. DYER
INSTITUTION: Institute of Marine Studies, Plymouth Polytechnic

TITLE: "Modelling cohensive sediment transport."

SPONSOR(S): Water Research Centre

START DATE: May 1987 **COMPLETION DATE:** 1989

DESCRIPTION OF PROJECT: The parameterisation of sedimentary processes within estuaries is being investigated from the basis of up-to-date research findings. These processes include settling, erosion and consolidation. These parameterisations are being tested in simple estuarine models to investigate the relative importances of the various processes to estuarine sedimentation. These parameterisations will be developed for use in regional scale models.

OUTLINE OF PROGRESS UP TO END 1988: Various parameterisations have been tested in a one-dimensional model estuary to examine the relationship between the tidal flows, and the response of the sediment. The inherent lags are important in causing the residual transport of sediment, and it is apparent that the ebb flood dominance of the water flow is displaced relative to that for the suspended sediment flux.

PUBLICATIONS: Dyer, K.R. and Evans, E.M. A study of the dynamics of the turbidity maximum in a homogenious tidal channel. Journal of Coastal Research (In press).

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): Dr. E.M. EVANS and Professor K.R. DYER

INSTITUTION: Institute of Marine Studies, Polytechnic South West, Plymouth

TITLE: "Modelling Cohesive Sediment Transport"
SPONSORS: Water Research Centre.

START DATE: Completed 1989

OUTLINE OF PROGRESS UP TO END 1989:

DESCRIPTION OF PROJECT: The parameterization of sedimentary processes within estuaries was investigated using a simple one-dimensional model. Additionally an improved technique was developed for modelling bed shear stress in laterally averaged two-dimensional models.

OUTLINE OF PROGRESS: The one-dimensional modelling showed that the accurate specification of the critical erosion stress was more important than the specification of the settling velocity.

PUBLICATIONS:

DYER, K.R. & EVANS, E.M., 1989. Dynamics of the turbidity maximum in a homogeneous tidal channel. Journal of Coastal Research, Special Issue No. 5, 23-30.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr E A Delo
Mr T N Burt

INSTITUTION: Hydraulics Research Ltd

TITLE: Engineering application of academic research in cohesive sediments

SPONSOR(S): Department of the Environment (CID)
Hydraulics Research Ltd

START DATE: April 1987 **COMPLETION DATE:** March 1990

DESCRIPTION OF PROJECT:
To collaborate with university and polytechnic researchers carrying out research on cohesive sediments with other financial support, by providing staff support, experimental facilities at HR and services.
To collate and interpret cohesive sediment research carried out by universities, collaboratively or otherwise, so as to make it available for practical engineering applications.

OUTLINE OF PROGRESS UP TO END 1988:
Response of cohesive beds to fluid shear. HR is working in collaboration with Plymouth Polytechnic. Measurement of the velocities in three dimensions in the HR carousel flume have been conducted and used to verify a 3D model of the flow set up by Plymouth.
Cohesive sediment modelling. HR is working with Liverpool University. Laboratory tests have been conducted at HR on mud from Grangemouth Docks to determine its erosional, consolidation, entrainment and settling on slopes properties.

PUBLICATIONS:
None to date.

COHESIVE SEDIMENTS RESEARCH - EXISTING PROJECTS

INVESTIGATOR(S): Dr E A Delo
INSTITUTION: Hydraulics Research Ltd

TITLE: Engineering application of academic research in cohesive sediments

OUTLINE OF PROGRESS UP TO END 1989:

Two collaborative research projects are currently underway and one collaborative research project has been completed in this contract. One continuing project is with Polytechnic Southwest (formerly Plymouth Polytechnic) which began in the later part of the year 1987/88. The project with Liverpool University began in Autumn of 1988 and is now complete. A collaborative project with Birmingham University is due to commence in Spring of 1990.

Response of cohesive beds to fluid shear

Tests have been conducted in the HR carousel flume to measure the three components of the velocity field. This data was used in the calibration of a turbulence numerical model of the carousel flow set up by the Polytechnic. Flush mounted shear stress probes have been fitted into the HR carousel flume and tests have been completed to measure the bed shear stress. These have been compared with the results of the numerical model.

Cohesive sediment modelling

This project with Liverpool University has been completed recently. Laboratory tests have been conducted at Hydraulics Research to look at the erosion, entrainment, consolidation and settling properties of mud from Grangemouth Docks. A collaborative field survey exercise at Grangemouth was undertaken in which standard measurements of flow and suspended solids were obtained at six points on the Firth of Forth. The data was used in the calibration of the cohesive sediment transport models developed by Liverpool University.

The transport of cohesive sediments in estuaries

Collaborative work with Birmingham University on a SERC funded project is due to commence in Spring of 1990.

PUBLICATIONS:

Grangemouth Mud Properties. Report SR 197, February 1989.
The Hydrodynamics of the Carousel. Report SR 223, January 1990 (in final draft)
Grangemouth Fluid Mud Study: Field Investigation. Report SR 224, January 1990 (in final draft)

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): Dr E A Delo, Mr T N Burt
INSTITUTION: Hydraulics Research Ltd

TITLE: Siltation and stability of dredged channels

SPONSOR(S): Department of the Environment (CID)

START DATE: April 1986 **COMPLETION DATE:** March 1988

DESCRIPTION OF PROJECT:

To use HR experimental facilities to define more precisely the mechanism of siltation of dredged channels by settlement of sediment from suspension, so that maintenance dredging quantities can be more accurately forecast.
To determine through literature review and laboratory experiment, the stable angle of repose of channel side slopes under flowing water for mud at different densities.

OUTLINE OF PROGRESS UP TO END 1988:

The project has been completed as described above. See the report list below.

PUBLICATIONS:

HR Report SR 117 The stability of cohesive dredged slopes. August 1987.
HR Report SR 154 The stability of cohesive dredged slopes under wave action. February 1988.
HR Report SR 180 Siltation of cohesive dredged slopes manual. June 19888.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Mr N V M Odd
Mrs M P Kendrick

INSTITUTION:
Hydraulics Research Ltd

TITLE: Fluid mud processes

SPONSOR(S): Department of the Environment (CID)

START DATE: April 1985 COMPLETION DATE: March 1988

DESCRIPTION OF PROJECT:
To establish by experiment the range of wave and tidal conditions under which near-bed fluid mud suspensions are created and transported. To develop a general theory which describes the motion of a fluid mud layer and incorporate it in an existing computational mud transport model. To formulate, through laboratory studies, engineering solutions to fluid mud flow. To construct field instruments to measure the flow of fluid mud layers.

OUTLINE OF PROGRESS UP TO END 1988:
The project has been completed as described above. See the report list below.

PUBLICATIONS:
HR Report SR 84 An analysis of the behaviour of fluid mud in estuaries. March 1986.
HR Report SR 88 Laboratory experiments on a near-bed turbid layer. June 1987.
HR Report SR 129 Measurement of fluid mud layers - field instrument developments. March 1987.
HR Report SR 147 A two-dimensional model of the movement of fluid mud in a high energy turbid estuary. January 1988.
HR Report SR 162 Laboratory investigation of measures to reduce fluid mud siltation in dredged navigation channels. February 1988.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr E A Delo
Mr T N Burt

INSTITUTION:
Hydraulics Research Ltd

TITLE: Estuarine Muds

SPONSOR(S): Department of the Environment (CID)

START DATE: April 1985 COMPLETION DATE: March 1988

DESCRIPTION OF PROJECT:
To review the literature and produce a working manual on the engineering behaviour of mud. To determine by experiment in the HR carousel the factors governing erosion and deposition in the tidal cycle. To study the consolidation of mud beds in the laboratory and to construct a mathematical model. To quantify the effect on the erosion characteristics of various proportions of sand in a mud bed.

OUTLINE OF PROGRESS UP TO END 1988:
The project has been completed as described above. See the report list below.

PUBLICATIONS:
HR Report SR 77 The hydraulic engineering characteristics of estuarine muds. Dec 1986.
HR Report SR 95 Simulation and experimental determination of a consolidating mud deposit. July 1987.
HR Report SR 138 The behaviour of estuarine muds during tidal cycles. February 1988.
HR Report SR 149 Consolidation and erosion of estuarine mud and sand mixtures. February 1988.
HR Report SR 164 Estuarine muds manual. February 1988.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): G. C. Sills

INSTITUTION: Oxford University Engineering Department

TITLE: Properties of surface layers of sediment beds

SPONSOR(S): S.E.R.C.

START DATE: 1st March 1985 **COMPLETION DATE:** 31st August 1988

DESCRIPTION OF PROJECT:

Laboratory-based study of sediment deposited in settling columns, consolidating under its own weight. The effects of initial salinity, initial concentration and time are examined, with relation to the development of erosion resistance.

OUTLINE OF PROGRESS UP TO END 1988:

Project completed. At initial concentrations of sediment lower than those at which effective stresses exist (i.e. before a supporting structure develops in the bed), the consolidation process shows little evidence of creep. This is in contrast to an earlier study at higher initial concentrations. In both studies, an aging effect was noted in the increase of shear strength with time at constant effective stress. In this study, there was little dependence of salinity level in the range 0.2 - 5ppt

PUBLICATIONS:

In preparation.

The following publications from the earlier S.E.R.C. supported study may be noted:

D.McG. ELDER and G.C. SILLS Time and stress dependent compression in soft wediments. ASCE Symp. Prediction and Validation of Consolidation, San Francisco, October 1984.

G. C. SILLS and D.McG. ELDER The transition from sediment suspension to settled bed. Proc. Workshop Estuarine Cohesive Sediment Dynamics, from series 'Lecture Notes on Coastal and Estuarine Studies', Ed. A. J. Mehta, Springer-Verlag, November 1984, Tampa, Florida.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): G. C. Sills

INSTITUTION: Oxford University Engineering Department

TITLE: Sediment behaviour in the Irish Sea

SPONSOR(S): D.o.E./M.A.F.F.

START DATE: 1st October 1983 **COMPLETION DATE:** 31st March 1988

DESCRIPTION OF PROJECT:

Field and laboratory study of sea-bed parameters. Settling column simulations of in situ deposition and consolidation progress are compared with in situ measurements and those made on cores recovered from the sea-bed.

OUTLINE OF PROGRESS UP TO END 1988:

Project completed. Three cruises on M.A.F.F. Research Vessel Cirolana allowed in situ pore pressures and density to be measured. Loss of sediment during coring was examined, and found to be significant for a barrel core with liner. Strengths and densities were measured on samples recovered from good cores, and compared with strengths and densities of laboratory sediment beds. The comparison provided evidence that creep had occurred in situ, and could be significant.

PUBLICATIONS:

G. C. SILLS and M. J. EDGE (1986) Sediment behaviour in the Irish Sea. DoE Report No. DOE/RW/87.090.

W. R. PARKER and G. C. SILLS (1985) Observation of corer penetration and sample entry during gravity coring.

Belgium

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): L. VAN DEN BOSCH
J. BERLAMONT

INSTITUTION: K.U.LEUVEN

TITLE: Consolidation of layered mud

SPONSOR(S): IMDC/K.U.Leuven

START DATE: 1988 COMPLETION DATE: 1990

DESCRIPTION OF PROJECT:

Studying the consolidation behaviour of layered mud deposits, in comparison with homogeneous mud, as a function of layer thickness, interval between mud supplies, and mud composition.

OUTLINE OF PROGRESS UP TO END 1988:

preliminary results

PUBLICATIONS:

Report to IMDC

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Ir. E. TOORMAN

INSTITUTION:
K.U.LEUVEN

TITLE: F.E. model for fluid mud flow towards pumping wells

SPONSOR(S): NFWO/K.U.Leuven

START DATE: 1988 COMPLETION DATE: 1990

DESCRIPTION OF PROJECT:

The aim is the calculation of the location of the mud-water interface and velocity profiles in fluid mud layers flowing towards a pump suction bell in a 2-D vertical plain. The correct modelling of the mud behaviour requires a constitutive relation from which the viscosity can be determined at each point and each time step (including the consolidation effect). Results will be compared with experiments. It would be of interest to add sedimenttransport equations to include formation and erosion of mud layers.

OUTLINE OF PROGRESS UP TO END 1988:

Finite element software has been developed, solving the general Navier-Stokes equations, including special modules to deal with Non-Newtonian behaviour and mesh adjustement. The different behaviour of the water layer and the mud layer is taken into account. Presently the work is focused on the solution of numerical instabilities. A simple polynomial fit of experimental viscosity-shear rate data is used as constitutive equation. More general constitutive equations will be developed in the future.

PUBLICATIONS:

TOORMAN E.A. and BERLAMONT J.E., 1989 - A Finite Element Program for Mud Flow. - Finite Element Analysis in Fluid Flow (T.J. Chung and G.R. Karr, Ed.), The University of Alabama in Huntsville Press, Huntsville, AL.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):	INSTITUTION:
ir. P. DE LAET	Waterbouwkundig Laboratorium Borgerhout - Antwerpen,
ing. J. ENGELS	Laboratory for Hydraulics Research - Ministry of Public Works.

TITLE: Improvement of the efficiency of agitation dredging.

SPONSOR(S): Ministry of Public Works - Haecke & Van der Meerssche - Dredging International.

START DATE: 01-01-1986 **COMPLETION DATE:** 31/12/1990

DESCRIPTION OF PROJECT:

The entrance-channels towards the maritime locks along the river Scheldt near Antwerp are maintained by agitation dredging. First aim of the study was to understand the mechanisms which are involved in this way of dredging. After this, an empirical improvement of the actual system could be elaborated. Later on, other agitation systems could be explored.

OUTLINE OF PROGRESS UP TO END 1988:

The most important mechanism of the studied plough was a scraper mechanism. The concentration of the suspended sediments was very low. Once the regime-velocity attained, the quantity of displaced mud was independent of the length of the distance covered. The limitation of this distance improves the efficiency. The quantity of displaced mud increases with the regime-velocity until about 1,35 m/s in nature for mud densities 1,06 to 1,17 kg/dm^3. Above this velocity the increase of the quantity becomes marginal and the tractive power increases more rapidly.
Also the influence of the angle between the plough and the horizontal plane and its distance above the fixed bottom have been tested.

PUBLICATIONS:

"Mod. 452. - Improvement of the efficiency of agitation dredging. Report 1".
(In preparation, in Dutch).

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):	INSTITUTION:
ir. F. WENS, ir. I. COEN, ing. J. ENGELS	Laboratory for Hydraulics Research - Ministry of Publics Works.
dr. ir. M. VANTORRE	Office of Naval Architecture - State University Ghent.

TITLE: Determination of nautical bottom in muddy areas.

SPONSOR(S): Ministry of Public Works (Belgium).

START DATE: 1984 **COMPLETION DATE:**

DESCRIPTION OF PROJECT:

Study of the influence of loose sediments (mud) on the behaviour of ships navigating above it, by means of ship model tests carried out above a mud simulating material.
(In co-operation with Coastal Service of Ministry of Public Works; Decloedt N.V.; Haecon N.V. for full scale tests).

OUTLINE OF PROGRESS UP TO END 1988:

- Selection of a mud simulating material.
- Preliminary model tests with three ship-models above several layers of mud simulating material; tests were carried out with self-propelled models following a measuring beam.
- Theoretical investigation into the nature of internal waves.
- Preparation of definitive model tests in a towing tank with planar motion mechanism.

PUBLICATIONS:

- VANTORRE, M.; COEN, I. - On sinkage and trim of vessels navigating above a mud layer. 9th Int. Harbour Congress, Proc. Vol. II, pp.4. 149-161. Antwerp, 1988. (Also to be published in Terra et Aqua, August 1989).
- WENS, F.; DE WOLF, P.; VANTORRE, M.; DE MEYER, C. - A hydro-meteo system for monitoring shipping traffic in narrow channels in relation with the problem of the nautical bottom in muddy areas. P.I.A.N.C., 1990 (to be published.)
- Several internal reports (in Dutch).

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
ing. J. ENGELS

INSTITUTION:
Waterbouwkundig Laboratorium Borgerhout-Antwerpen,
Laboratory for Hydraulics Research - Ministry of Public Works.

TITLE: Determination of nautical depth in muddy areas.
Simulation of mud in model investigations.

SPONSOR(S): Ministry of Public Works (Belgium).

START DATE: 1984 COMPLETION DATE: (1988)

DESCRIPTION OF PROJECT:
Investigation of the physico-chemical characteristics of mud from the river Scheldt and the North Sea. Research on simulation materials for use in model investigations.

OUTLINE OF PROGRESS UP TO END 1988:
Determination of the physical and rheological characteristics of mud and development of techniques in that respect. Selection of two simulation materials which to a certain extent can be used for model investigations.

PUBLICATIONS: (Internal reports - in Dutch).
- Mod. 428 : Nautical bottom in muddy areas.
  Basic report nr. 1.
  Mud simulation in a physical model.
- Mod. 302 : Investigation on the siltation of the entrance to the lock at Kallo (Antwerp).
- Mod. 452 : Research on the improvement of agitation dredging techniques (completed in 1989).

France

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
P. LE HIR

INSTITUTION: IFREMER
(Institut Français de Recherche pour l'Exploitation de la Mer)

TITLE: Mathematical modelling of fluid mud and turbidity maximum in the Loire estuary

SPONSOR(S): IFREMER, APEEL

START DATE: 1989 COMPLETION DATE: 1993

DESCRIPTION OF PROJECT:

- 3D and 2D vertical model for cohesive sediment transport application to the Loire estuary.
- Fluid mud consolidation (observations and modelling).
- Integration of the model in a water quality software.

OUTLINE OF PROGRESS UP TO END 1989:

Simulation of a "dynamic" turbidity maximum with a one dimensional model.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
P. BASSOULLET, J. L'YAVANC, P. LE HIR

INSTITUTION: IFREMER
(Institut Français de Recherche pour l'Exploitation de la Mer)

TITLE: General study of cohesive sediment processes

SPONSOR(S): IFREMER

START DATE: 1988 COMPLETION DATE: 1992 ...

DESCRIPTION OF PROJECT:

- Field and laboratory measurements for
  - settling velocity
  - rheological properties of natural mud
  - consolidation processes
- Continuous field measurements of flow, turbulence and turbidity over mud bottoms

OUTLINE OF PROGRESS UP TO END 1989:

- Mud level variations observations in a macrotidal estuary.
- Yield stress and bulk concentration measurements of natural muds (same estuary).
- Settling column and particle size analyser (Coulter counter/laser) ...
- Acquisition of E.M. flow meter and data logger for continuous measurements.

PUBLICATIONS:

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
P. LE HIR, P. BASSOULLET, J. L'YAVANC

INSTITUTION: IFREMER
(Institut Français de Recherche pour l'Exploitation de la Mer)

TITLE: Mathematical modelling of cohesive sediment transport in the Morlaix estuary.

SPONSOR(S): IFREMER

START DATE: 1987 COMPLETION DATE: 1990

DESCRIPTION OF PROJECT:

- 2D and 1D depth-averaged model of cohesive sediment transport, coupled to hydrodynamics models and a multi-layered soil model.
- Integrated software for dissolved and/or particulate constituents transport.

OUTLINE OF PROGRESS UP TO END 1989:

- Field measurements of turbidity, SSM, ...
  bathymetry and sediment budget
  particle size analysis.
- Calibration of the model.
- Application to free and attached bacteria becoming.

PUBLICATIONS:

LE HIR P., BASSOULLET P., L'YAVANC J., 1989a. "Modelling mud transport in a macrotidal estuary" in "Advances in Water Modelling and Measurement", Ed. PALMER, Pub. BHRA, The Fluid Engineering Centre, Bedford, U.K.

LE HIR P., BASSOULLET P., L'YAVANC J., 1989b. "New-developments about mud transport models : application to a macrotidal estuary". Compte-rendu de l'International Symposium on Sediment Transport Modeling. New Orleans, Aug. 14-18, 1989. Ed. Sam S.Y. Wang, Publication de L'ASCE.

LE HIR P., GUILLAUD J.F., SALOMON J.C., 1989c. "Applications of a cohesive sediment model to dissolved and particulate contaminants transport". Compte-rendu du 23e congrès de l'AIRH, Ottawa, 21-25 août 1989.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S): D Fritsch
C Teisson

INSTITUTION:
Laboratoire National
d'Hydraulique EDF-DER FRANCE

TITLE: Numerical modelling of suspended sediment transport

SPONSOR(S): Electricite de France (EDF) & Service Technique
Centre de Compiegue (STC)

START DATE: January 1986 COMPLETION DATE: December 1988

DESCRIPTION OF PROJECT:
To test a 2D depth-integrated numerical model of suspended sediment transport on a real case.

Application to the study of siltation in the outer-port of St Nazaire under action of tidal currents.

OUTLINE OF PROGRESS UP TO END 1988:

Project completed.

The model has been calibrated against in situ measurements. The comparison between computed and measured bed elevation shows the importance of mud sliding at the bottom depending on the slope in the physical process.

PUBLICATIONS:

- LNH report HE 42/85.21 - Numerical models for sediment transport in suspension in coastal areas - May 1985
- LNH reports HE 42/89.08. Two applications of a numerical model of suspended sediment transport (Coole SUBI) - February 1989.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Prof. A. Watanabe
Assoc. Prof. M. Isobe
Mr. H. N. Trien

INSTITUTION:
University of Tokyo

TITLE: Mud Transport Due to Waves and Currents

SPONSOR(S): Grant-in-Aid for Scientific Research.
Ministry of Education

START DATE: April 1989 COMPLETION DATE: March 1990

DESCRIPTION OF PROJECT:

The aim of this project is to establish a method for estimating the mud transport rate in a wave-current coexisting field. The transport rate of Kaolinite is measured in a wave flume in which waves and a current are generated at the same time. A numerical model is developed based on the laboratory experiment.

OUTLINE OF PROGRESS UP TO END 1988:

Measuring instruments of mud concentration are being developed by using electric resistence, lasor beams, and ultrasonic waves. Basic characteristics are investigated.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
E. Yauchi
K. Kato

INSTITUTION:
Tech. Res. Inst. TOA CORP.

TITLE:
The diffusion of a mud lump falling.

SPONSOR(S): TOA CORPORATION

START DATE: April 1988 COMPLETION DATE: March 1990

DESCRIPTION OF PROJECT:

The falling characteristics of a mud lump dumped from a barge is studied by field and laboratory experiments.

OUTLINE OF PROGRESS UP TO END 1988:

The falling pattern and associated diffusion coefficient are estimated by the nondimensional falling index and the dispersion factor.

PUBLICATIONS:

The diffusion coefficient and the falling type of a mud lump, Proc. of the 36th Japanese Conference on Coastal Engineering, 1989.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Mr S Nakano

INSTITUTION:
Univ. of Tokushima, JAPAN

TITLE: Interaction between waves and soft mud in a uniform current

SPONSOR(S): Univ. of Tokushima, JAPAN
the Grant-in-Aid for Sci. Res., the Ministry of Education and Culture, JAPAN
START DATE: April 1988 COMPLETION DATE: March 1990

DESCRIPTION OF PROJECT:
To estimate the wave damping over muddy sediments, the interaction between waves and a muddy bottom is investigated. In this project, especially, the effects of water flow on the wave damping due to the interaction are calculated and checked by the experiments.

OUTLINE OF PROGRESS UP TO END 1988:
It was proposed that the analytical method of the interactive effect between waves and a muddy bottom in a uniform current.
The mud layer is treated as several divided layers which are Newtonian fluids which viscocities are automatically determined by the velocity field in each layer.
The mesurements of the wave attenuation rate and the height of mud waves were conducted in several flow conditions (favorable, no and opposing flow).

PUBLICATIONS:
Proc. the 36th Coastal Eng. in Japan (submitted, in Japanese),1989

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Mr. K.Murakami
Mr. F.Suganuma
Dr. H.Tsuruya
Mr. K.Kato
Mr. S.Eguchi

INSTITUTION:
Port and Harbour Research Institute

TITLE: Numerical Simulation of mud transport

SPONSOR(S): Bureau of Ports and Harbours, Ministry of Transport

START DATE: April 1988 COMPLETION DATE: March 1990

DESCRIPTION OF PROJECT:

To develop a simulation program in collaboration with 4th District Port Construction Bureau.
To estimate the total amount of deposition in Kumamoto Port which is under construction.
To develop countermeasures for silutation.

OUTLINE OF PROGRESS UP TO END 1988:

Field observation. P.H.R.I. was working in collaboration with the 4th District Port Construction Bureau. Measurement of the velocities, waves, and deposition heigths,etc. have been conducted in Kumamoto Port.
Development of the simulation program has been conducted in P.H.R.I. with the aid of the Supercomputer NEC SX-1E.

PUBLICATIONS:

Proc. 36th Japanese Conf. on Costal Eng.,1988. (in Japanese)

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr. H.Tsuruya Mr. S.Eguchi
Mr. J.Takahama

INSTITUTION:
Port and Harbour Research Institute

TITLE: Experiments on erosion rate of mud beds under the combined action of waves and currents

SPONSOR(S):

START DATE: April 1987 COMPLETION DATE: March 1990

DESCRIPTION OF PROJECT:

To investigate the erosion rate of cohesive sediments under the combined action of waves and currents by using a wave soil channel.
To relate the erosion rate to the shear stress applied on the mud layer.

OUTLINE OF PROGRESS UP TO END 1988:

Experimental ralationship has been obtained, which is described in the report below. The critical shear stress for Bingham fluid is obtained by the rotary visco-meter and is used to yield the non-dimensional erosion rate.

PUBLICATIONS:

Proc. 35th Japanese Conf. on Costal Eng.,1988. (in Japanese)

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr N Mimura

INSTITUTION:
Dept of Civil Eng
Ibaraki Univ

TITLE: Erosion and deposition rates of cohesive sediments by waves

SPONSOR(S): Ministry of Education, Science and Culture
Ibaraki Univ
START DATE: April 1987 COMPLETION DATE: (in progress)

DESCRIPTION OF PROJECT:

Initiation, patterns, and rates of cohesive sediments erosion and deposition induced by surface waves are measured in a wave flume to establish appropriate expressions for these parameters mainly in terms of bottom shear stress.

OUTLINE OF PROGRESS UP TO END 1988:

1. Erosion and deposition were found to occur simultaneously under the action of waves, which is not the case for unidirectional flow.
2. A new experimental method were established to evaluate the gross rates of erosion and deposition by waves.
3. The measured rates of erosion and deposition were found to be well correlated with the bottom shear stress, when the erosional behavior is properly divided into three phases.

PUBLICATIONS:

N.Mimura et al.:Rates of mud erosion and deposition under wave action, Proceedings of 36th Japanese Conference on Coastal Engineering, 1989 (in Japanese).

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
E. Yauchi
M. Gomyoh

INSTITUTION:
Tech. Res. Inst. TOA CORP.

TITLE:
Sand covering method for seabed mud under waves

SPONSOR(S): TOA CORPORATION

START DATE: April 1987 COMPLETION DATE: March 1991

DESCRIPTION OF PROJECT:

To cope with environmental problems, a sand covering method has been tried. It is important to establish design criteria for placing sand over seabed mud under waves.

OUTLINE OF PROGRESS UP TO END 1988:

Experiments on behaviors of seabed mud under waves was done.

PUBLICATIONS:

None to date.

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Mr E. Yauchi
Mr M. Gomyoh

INSTITUTION:
Tech. Res. Inst. TOA CORP.

TITLE:
Mud behavior and wave damping under progressive waves

SPONSOR(S): TOA CORPORATION

START DATE: April 1985 COMPLETION DATE: March 1988

DESCRIPTION OF PROJECT:

To estimate the mud behavior under waves, wave damping and motion of clay beds are studied experimentally in a wave tank under various wave conditions.

OUTLINE OF PROGRESS UP TO END 1988:

See the report list below.

PUBLICATIONS:

Experimental study on mud motion and wave damping under progressive waves, Proc. of the 32nd Japanese Conference on Coastal Engineering, 1985.

Effect of mud characteristics on wave-mud interactions, Proc. of the 33rd Japanese Conference on Coastal Engineering, 1986.

COHESIVE SEDIMENTS RESERACH

INVESTIGATOR(S):
Mr. k. Murakami
Mr. F. Suganuma

INSTITUTION:
Port and Harbour Research Institute,
Ministry of Transport

TITLE: Study on Erosion and Deposition of Fine Cohesive Sediment in a Tidal Flow

SPONSOR(S): Ministry of Transport, JAPAN
START DATE: April 1985 COMPLETION DATE: March 1989

DESCRIPTION OF PROJECT:

The property of the erosinal and depositional behavior of cohesive fine sediments in turbulent shear flow is investigated by an annular rotating channel. The results are applied to the numerical simulation model of mud transport.

OUTLINE OF PROGRESS UP TO END 1988:

The project has benn completed as described above. See the report list below.

PUBLICATIONS:

Report of Port & Horbour Research Institute, Vol.28, No.1, Experimental Investigation on Erosion and Deposition of Fine Cohesive Sediment in an Annular Rotating Channel, March 1989. (in Japanese)

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr N Mimura

INSTITUTION:
Dept of Civil Eng
Ibaraki Univ

TITLE: Flocculation of clay and natural mud, and floc settling

SPONSOR(S): Ministry of Education, Science, and Culture
Ibaraki Univ
START DATE: April 1985 COMPLETION DATE: March 1987

DESCRIPTION OF PROJECT:
Laboratory experiments were performed using a jar tester-type mixing apparatus to determine the characteristics of flocculation of clay and natural mud suspensions, such as the effects of the kind of suspended particle and salinity on the degree of flocculation. Settling velocity of flocs have been correlated with floc diameter using data from previous studies as well as the present experiment.

OUTLINE OF PROGRESS UP TO END 1988:
Main results obtained up to end 1988 are as follows:
1. Floc growth reached an equilibrium state within 120 minutes for all suspended materials used.
2. All materials formed flocs under 10% salinity of ocean, which indicates flocculation in natural environment takes place in the upper reach in estuaries.
3. Flocs of natural muds were several times larger in diameter than those of clays. This may attribute to the existence of organic matter in the natural sediment-water system.
4. Settling velocity of flocs increases with proportional to the floc diameter.

PUBLICATIONS:
N. Mimura et al.:Characteristics of silt flocculation in estuaries and settling velocity of flocs, Proceedings of the 33rd Japanese Conference on Coastal Engineering, 1986 (in Japanese).
N.Mimura: Recent Japanese studies on cohesive sediment transport, Journal of Coastal Research, Special Issue #5, 1989 (in press).

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr. H.Tsuruya Mr. S.Eguchi
Mr. J.Takahama

INSTITUTION:
Port and Harbour Research Institute

TITLE: Determination of yield stress of soft muds with vane and slump test

SPONSOR(S):

START DATE: April 1985 COMPLETION DATE: March 1989

DESCRIPTION OF PROJECT:

To investigate the rheological properties of soft muds with the rotary visco-meter and to determine the yield stresses.
To develop the way to estimate the yield stress from the shear strength obtained by the vane test and from the slump value by the slump test.

OUTLINE OF PROGRESS UP TO END 1988:

The project has been completed as described above. See the report list below.

PUBLICATIONS:

Technical Note of P.H.R.I., No.655, June 1989. (in Japanese)
Proc. 36th Japanese Conf. on Costal Eng.,1989. (in Japanese)

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
Dr.Takeshi HORIE, Yasushi HOSOKAWA

INSTITUTION:
Port & Harbour Research Institute, Ministry of Transport

TITLE:
Field Measurement of Settling Flux of Fine Organic Particles to Bottom in Inner Bay

SPONSOR(S): Japanese Government (Environmental Agency,and Science & Technology Agency)

START DATE: April 1984 COMPLETION DATE: December 1988

DESCRIPTION OF PROJECT:

1. Evaluation of the trapping efficiency of Sediment-trap device.
2. Measurement of the vertical mass flux of suspended particles by Sediment-trap in inner bays.
3. Development of the analitical method to separate over all mass flux into two categolies,fresh detritus and resuspended cohesive sediments.

OUTLINE OF PROGRESS UP TO END 1988:

The developed sediment-trap shows good efficiency for particles' trapping in flowing water. In situ measurements were conducted by sediment-trap devices. The observed flux was unnaturally large near bottom due to the resuspension and undulation of cohesive bottom sediments. Using the defference of the contents of particles, we can separate the over-all flux into two categolies successfully. The net settling as well as the resuspension rate can be estimated with the suitable choice of the contents index .

PUBLICATIONS:

English manuscript is preparing for Coastal Engineering in Japan(1989).

COHESIVE SEDIMENTS RESEARCH

INVESTIGATOR(S):
K.Ashida
K.Sawai

INSTITUTION:
Disaster Prevention Research Institute,
Kyoto University

TITLE: EROSION AND STREAM FORMATION PROCESS ON A COHESIVE SEDIMENT BED

SPONSOR(S):

START DATE: 1974 COMPLETION DATE: 1982

DESCRIPTION OF PROJECT:

The investigators devised a handy test method of soil erodibility using a rotating inner cylinder. Using this device the relation between the rate of erosion and tractive force was obtained for the mixture of sand and bentonite.

On a bare slope many rills and gullies are usually formed and they form a complicated stream network. In this study the mechanism of stream network evolution is discussed from a view point of sediment hydraulics.

A stochastic simulation model is proposed to estimate the sediment yield from a bare slope. It is compared with some experiments carried out by the authors using an artificial rainfall.

OUTLINE OF PROGRESS UP TO END 1988:

The project has been completed as described above. See the report list below.

PUBLICATIONS:

Ashida, K. and K. Sawai: A Study on the Stream Formation Process on a Bare Slope , Annuals of the Disaster Prevention Research Institute, Kyoto University, No.18 B, 1975, pp.513-528 (in Japanese).

Ashida, K. and K. Sawai: Erosion and Cross Section on the Cohesive Stream Bed, Bulletin of the Disaster Prevention Research Institute, Kyoto University, Vol.26, Part 3, 1976, pp.145-161.

Sawai,K. and K. Ashida: A Test Method of Soil Erodibility by Means of the Rotating Inner Cylinder, Annuals of the Disaster Prevention Research Institute, Kyoto University, No. 22 B-2, 1979, pp.291-300 (in Japanese).

Sawai, K.: A Study on the Stream Network Evolution under Precipitation, Annuals Disaster Prevention Research Institute, No. 25 B-2, 1982, pp.317-326 (in Japanese).