IWRM-Indonesia Fact Sheet

Sustainable Rainwater Cisterns Based on Optimized Local Construction Materials

General Data

Plant type:	Roof-catchment rainwater cisterns
Location:	Pucanganom Village, Gunung Kidul Regency, Province of Yogyakarta Special Region, Indonesia (110.727399° E / 8.041955° S)
Constructed:	September 2012, May 2013 and September 2014
User:	Private household

Technical Data

Technology:	Optimization of mortar composition with rheological methods and by using only locally available source materials
Dimension (d/h)	2.5 m / 2.0 m
Volume:	9 m^3

1 Objective

An important aspect of the overall project IWRM was to rehabilitate and enlarge the existing water storage and distribution system in the project region to handle the additional water supplied by the new hydropower plant Bribin. Within this context, the leaking of domestic rain water cisterns in the village of Pucanganom prevents reliable water storage especially in the dry season. Although the rehabilitation with standard methods is basically known, it is often afflicted with high costs. Consequently, the objective of this subproject included was the development and rheological optimization of an appropriate mortar for the rehabilitation or even reconstruction of sustainable rain water cisterns to minimize the water losses due to cracks and to guarantee the secure and durable long time operation of the cisterns.

2 Optimization of mortar composition

Based on the experiences gained during a preliminary field study, the source materials for the further investigations were selected and carefully characterized considering their usage as mortar ingredients. It was evident that from a technical and economical point of view, the controlling of the rheological behaviour of the mortar is the key factor to achieve the best possible imperviousness of water cisterns. It would be desirable to have at one's disposal a practical guideline of how to compose the mortar according to its intended range of application.

Rehabilitation mortars may include, besides the main ingredients cement, sand and water, various organic or mineral additions, which influence the mortar properties. As commercially available additions are quite expensive and hardly available in the remote region of Gunung Kidul, alternative additives and admixtures were chosen to be examined. The main focus in this regard was on the investigation of local retail sugar as an alternative for liquefying additives. Further bentonite was tested as an alternative for commercial stabilisers. Moreover an Indonesian rice husk ash (abu sekam padi) was treated with different methods and the influence on the puzzolanic reaction was determined.

To determine the flow behaviour of the pure cement suspension phase of the mortar and to evaluate the influence of the different additives and admixtures rheological investigations were performed. A measuring system consisting of a high-end rheometer (Haake MARS) combined with a measuring cell especially developed for cement suspensions were used. Following the investigation of the flow behaviour of the cement suspensions with the rheometer, the consistency of different mortar mixtures was examined with conventional methods and compared with the results of an industrial mixture for drinking water cisterns in Germany as well as with the Indonesian reference mixture. Based on the results from the rheological investigations of cement suspensions and the fresh mortar experiments, the mechanical properties were finally determined on hardened mortar specimens.

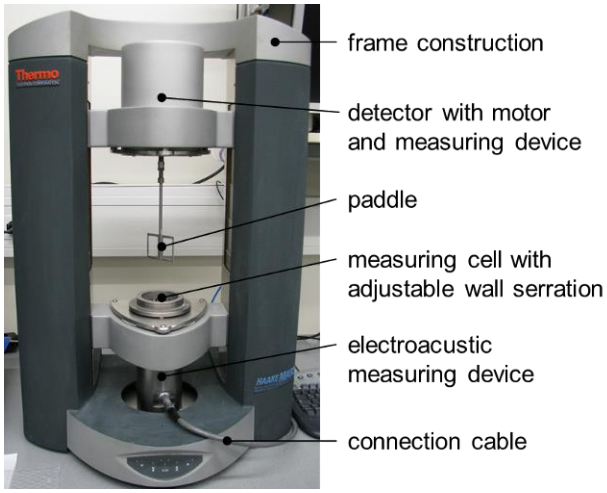
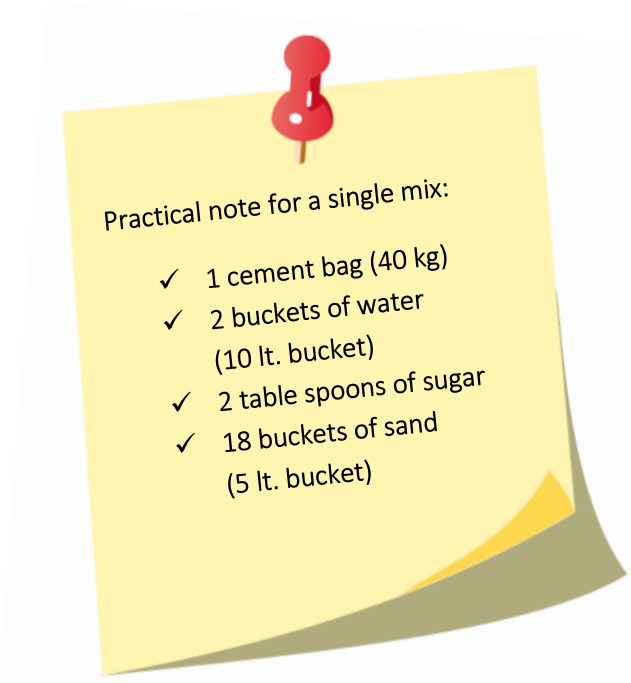


Fig.1. Rheometer Haake Mars



3 Implementation and Results

The results of the optimization of mortar composition led to three main features which are (I) reduction of cost by using only locally available building materials, (II) cement reduction by lower w/c-ratio leads to higher durability and (III) better workability by use of saccharose. The methodology of how to compose the mortar composition according to its intended range of application was summarized in a comprehensible practical guideline. It was translated into English – Indonesian language and handed over to the villagers as an important part of the capacity development measures. The basic concept was already discussed in detail and field-tested with the local persons during the joint construction of a complete new cistern in September 2012. The experiences gained in-situ were used to further adapt the concept to the local situation. The revised concept including the finally developed material composition was successfully implemented with the joint construction of two further cisterns in May 2013 and September 2014.

(a) Mixing of the mortar in-situ

(b) Prefabricated reinforcement cage

(c) Application of the inner mortar layer

(d) Application of the outer mortar layer

(e) application of the mortar on the ceiling

(f) A complete rainwater cistern

Fig. 2. Pictures impression of the implementation

4 Project Partners

Karlsruhe Institute of Technology

Ministry of Public Works and Public Housing

Province of Yogyakarta Special Region

National Nuclear Energy Agency

5 Contact

IWRM-Indonesia Project Coordinator:	Institute for Water and River Basin Management, KIT Prof. Dr.-Ing. Franz Nestmann, franz.nestmann@kit.edu
Sub-Project and Technical Contact	Institute of Concrete Structure and Building Materials, KIT Prof. Dr.-Ing. Harald S. Müller, harald.mueller@kit.edu Dipl.-Ing. Raphael Breiner, raphael.breiner@kit.edu