A New Technology Making the Most Use of Materials available on Site Placement Work of the Concrete made of Boulders

(The case of Ubasawagawa Sabo Dam and Groundsills of Uono River)

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1. Introduction

It was necessary to make the most use of earth materials generated with excavation work, because the materials require considerable areas for stockpiling, management for safety and environmental preservation and associated costs. Especially in the case of sabo project launched in mountain areas, stockpiling of excavated materials requires considerable amount of cost due to narrow space available on site and rather long distance of conveyance. A new technology aiming at effective use of materials has therefore been strongly needed. The construction technology using soil-cement is an option which is widely used throughout Japan. Similar technology referred to as INSEM has been developed and used in the area of Yuzawa Sabo Project.

The maximum size of materials used for INSEM is rather small, smaller than 80 mm, so that the materials over 80 mm have been left stacked as useless. The use of the materials over 80 mm has been a longstanding problem.

Large boulders have been put in sabo dams and the concrete using large boulders is referred to as boulder concrete, but the size of boulders in the boulder concrete is rather limited depending on workability on site.

New technology developed this time intends to use boulders of which size is, unlike the existing boulder concrete, widely distributed.

2. New Boulder Concrete

Boulder concrete employing newly developed technology uses boulders screened from excavated rubble. The size of boulders ranges from approximately 80 mm to 500 mm. Boulders screened are conveyed and put at the placement site surrounded with mold forms. Boulder concrete placement work is finished by pouring high fluidity concrete into the voids among boulders.

A demonstration project was launched in 2001 in order to make the technology much more feasible focusing on the following points;

1) higher workability and efficiency by means of utility machines,
2) much more mechanization of mold form work and compaction work,
3) appropriate prescription of the concrete mix by means of commercial plants.

The technology was applied to the foundation of the groundsills of Ubasawa valley
in the catchment of Nobori river

Coring test of the finished concrete proved that there was no void in the structures and distribution of aggregate in the concrete was satisfactorily homogeneous. Since all the boulders were washed, the bond between boulders and concrete is sufficient. As a result, uniaxial compressive strength of the concrete is 25.2N/mm and it is large enough to sustain the structures.

Coring test state

3. Construction Procedure

3-1. Construction Procedure of the Boulder Concrete works

1) Collection of boulders

   Boulders of which size ranges from 80 to 500mm are screened and collected using
   the skeleton bucket attached to backhoe.. Boulders collected are washed.

2) Boulders placement work

   Boulders are cast as many as possible into the designated section surrounded by mold forms.

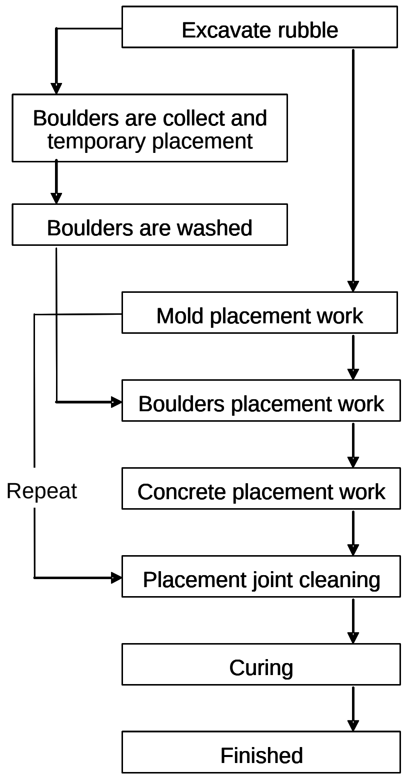
3) Concrete placement work

   High fluidity concrete is poured into voids of boulders layer.

4) Concrete curing

5) Placement joint cleansing and curing

   The processes from 1) to 5) are repeated until the structure is completed.



Work flow

(2) Workability

The mold forms made of iron are efficient and workable, but the forms can be used for the sections below the elevation of backfill because the forms must be pressed to prevent uplift movement due to the pressure derived from uncured concrete. The thickness of a cast of concrete might be, in general, from 0.9 m to 1.5 m.

The volumetric rate of boulders is approximately 50 %. High fluidity concrete required to fill all the voids results in rather high unit cost of concrete, but, as a whole, the new boulder concrete method is proved to be cost-effective.

Washing boulders state

Pouring concrete state

Placement boulders state

Placement joint cleaning state

Concrete mix to fill voids

Designated Strength	Flow (cm)	Air entrained (%)	Maximum Size of aggregate (mm)	W／C (%)	Unit cement (kg/m^2)	Cement	Admixture
―	65	3.0	25	60	430	BB	Water reducing admixture

4. Problems remained to be solved

With regard to the strength, taking into account heterogeneous property of the concrete, there must be room to make further study on methods for tests and examination of data acquired. It is necessary to prepare engineering manuals to illustrate the property of the concrete such as durability, the quality and size of aggregates, the part of a structure to be applied, criteria for the application of the concrete and etc.

5. Conclusion

There are still problems remained to be solved, the boulder concrete provides many advantages in reduction in environmental detrimental effects and cost. The number of structures, sabo dams and consolidation dams, so far accomplished is increasing in the catchments of Uono river and Nobori river accounting for more than 10. Problems remained must be solved by adding cases and the method might be established and authorized as an ordinary construction technology.

※Translated from Journal of Japan Sabo Association, Sabou to Chisui, Vol.168, pp.28-30, 2005