JIS A 5022 ： 2018

Recycled aggregate Concrete class M

Commentary

This commentary describes the items which provided and mentioned in this standard however this is not a part of the standard.
This commentary is edited and published by Japanese Standards Association and all the inquiry is contacted to Japanese Standards Association.

1. Details to this amendments

The Ministry of Economy, Trade and Industry entrusted “Standardization investigation and research for recycling concrete mass of construction waste” to Japan Concrete Institute in 2002. Correspondingly, the Japan Concrete Institute has organized Investigation and research committee and with deliberating by Japanese Industrial Standards Committee, established this standard in 2007 and revised in 2012 and made addendum in 2016 (hereinafter referred to as the "former standard") before this amendment.

This time, Japan Concrete Institute enhancing reliability of the quality for recycled aggregate concrete in this standard and by means of further promotion, organized Committee and generated draft of JIS amendment.

2. Purpose of this amendment

Recently the generation amount of demolished concrete has not been changed and is still a huge amount. Meanwhile the reusing percentage of demolished concrete has been 97% or over. However most of the usage is for pavement, road bed materials or back fillings. From now on, due to the newly construction for roads has been decreased, the demand of using concrete waste for paving road bed materials will be less. Moreover the demand-supply balance of concrete waste will be lost and recycled aggregate should be used for concrete more initiatively in near future. Therefore this standard was enacted in 2007 and amended in 2012 and 2016.

Thus ten years have passed since the establishment of this standard, the manufacturers who got the certification of JIS according to this standard and the actual productions are increasing however the recycled aggregate concrete conform to this standard has not been promoted. Consequently, to raise up the reliability for the quality of recycled aggregate concrete in this standard and also to promote them more widely, this standard shall be amended.

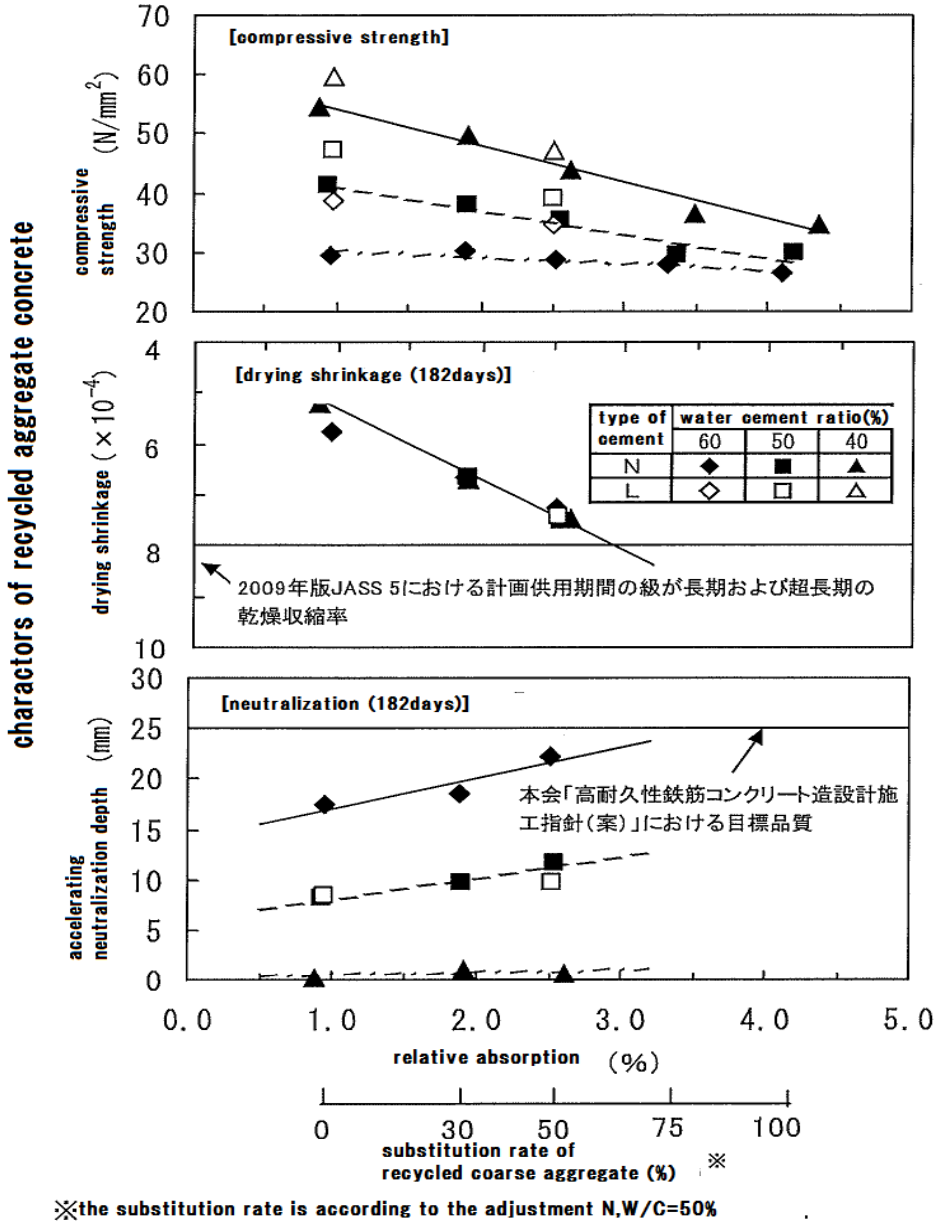
3. Issue under deliberation

3.1 Name for the standard and types of recycled aggregate concrete class-M

The types of concrete using recycled aggregate M in JIS A 5022:2007 was provided by the combination of maximum size of coarse aggregate, slump and nominal strength. Moreover the concrete using recycled aggregate M was possible to apply for concrete structure of limited usage such as a member of underground structure which is not effected by drying- shrinkage or freeze thaw. After that, at the amendment in 2012, due to the simple method to evaluate frost damage resistance for recycled aggregate was developed according to the former inspection results, the frost damage resistance class was provided which allowed to use as a member effected by freeze thaw.

Meanwhile the expansion of the combination of recycled aggregate was discussed at the Committee of Preparing Draft for Amendment. In JIS systems for recycled aggregate concrete, the recycled aggregate H conform to JIS A 5308, the concrete using recycled aggregate L conform to the part or a member which is not required the high durability and the concrete using recycled aggregate M conform to the part or a member which is not effected by drying shrinkage or freeze thaw were applied. However the low quality recycled aggregate can be satisfied enough quality for concrete when using mixture with natural aggregate according to the test results [(1)~(8)]. Depends on the mixture ratio of recycled aggregate L and natural aggregate, the quality is believed as same quality as the recycled aggregate M. Therefore to approve the usage of the mixture of recycled aggregate L and natural aggregate was considered in this standard.

Commentary drawing 1 shows the relation between water absorption [relative absorption calculated by the following formula] of aggregate depends on the mixture ratio after mixture and the characters of recycled aggregate concrete.



Commentary figure 1 ： relation between relative absorption and the character of recycled aggregate concrete

$$Q_t = \frac{Q_v G \times a + Q_r G \times b + Q_v N \times c + Q_r N \times d}{a + b + c + d}$$

Where, Q_1 : relative water absorption of aggregate (%)

QvG : absorption of natural coarse aggregate (%)

QvN : absorption of natural fine aggregate (%)

QrG : absorption of recycled coarse aggregate (%)

QrN : absorption of recycled fine aggregate (%)

a, b, c, d : absolute volume of each aggregate (L/m^3)

As mentioned above, the quality of recycled aggregate concrete is various depends on the mixture ratio and the quality of the mixed concrete made by the recycled aggregate L and natural aggregate shall be almost as same quality as the concrete using recycled aggregate M. Not only by the example of commentary figure 1, the test results that strength, elastic modulus and drying shrinkage are definitely effected by mixture ratio of recycled aggregates are reported. For neutralization, the report said if the mixture ratio of recycled aggregate is big, the neutralization depth is a little bit bigger however it's not much difference from normal weight concrete. For frost damage resistance, some reports said that if the mixture ratio of recycled aggregates is small, it is improved while the other report said even if the low quality recycled aggregate is mixed a small amount, the character of concrete for frost damage resistance is observed to effect. According to the inspection for the performance of concrete structure using low quality recycled aggregate, another report said the mixture usage of recycled aggregate and natural aggregate can provide enough performance.

Accordingly, when recycled aggregate L is used by mixture with natural aggregate, the fixed performance is provided in the range of appropriate mixture ratio. However the deterioration might be occurred when low quality recycled aggregate is mixed in the concrete for frost damage resistance or in practically the quality management of recycled aggregate L should be properly controlled.

However considering the concrete using recycled aggregate M conform to this standard is only for a member which is not effected by drying shrinkage or frost damage, the frost damage can be avoid for concerning. Moreover if the quality management of recycled aggregate L shall be required as same condition for recycled aggregate M, the quality of concrete conform to this standard can be provided in practically.

Hence except for the concrete using recycled aggregate class H, the concrete made by the mixture of recycled aggregate L and natural aggregate is allowed to treat as the same quality as the concrete using recycled aggregate M.

However according to the reason above, the concrete using mixture of recycled aggregate L shall not be allowed to use for frost damage class. Moreover the former name of the standard " Concrete using recycled aggregate M" was changed to "Recycled aggregate concrete-class M".

3.2 Mixture usage of recycled aggregate L and natural aggregate

According to the allowance above, the discussion was held regarding the quality of recycled aggregate L and its management. Because in Annex A of JIS A 5023 (recycled aggregate L for concrete) the standard value and the management method are not strict than that of the recycled aggregate M. As a results of discussion, if using the mixture of recycled aggregate L and natural aggregate, the quality is required as same as recycled aggregate M and the upper limit of the mixture ratio is specified. Moreover for the recycled aggregate L, the contents of impurities or test method shall be satisfied the requirement of Annex A as an applied condition.

3.3 Chloride contents of recycled aggregate M

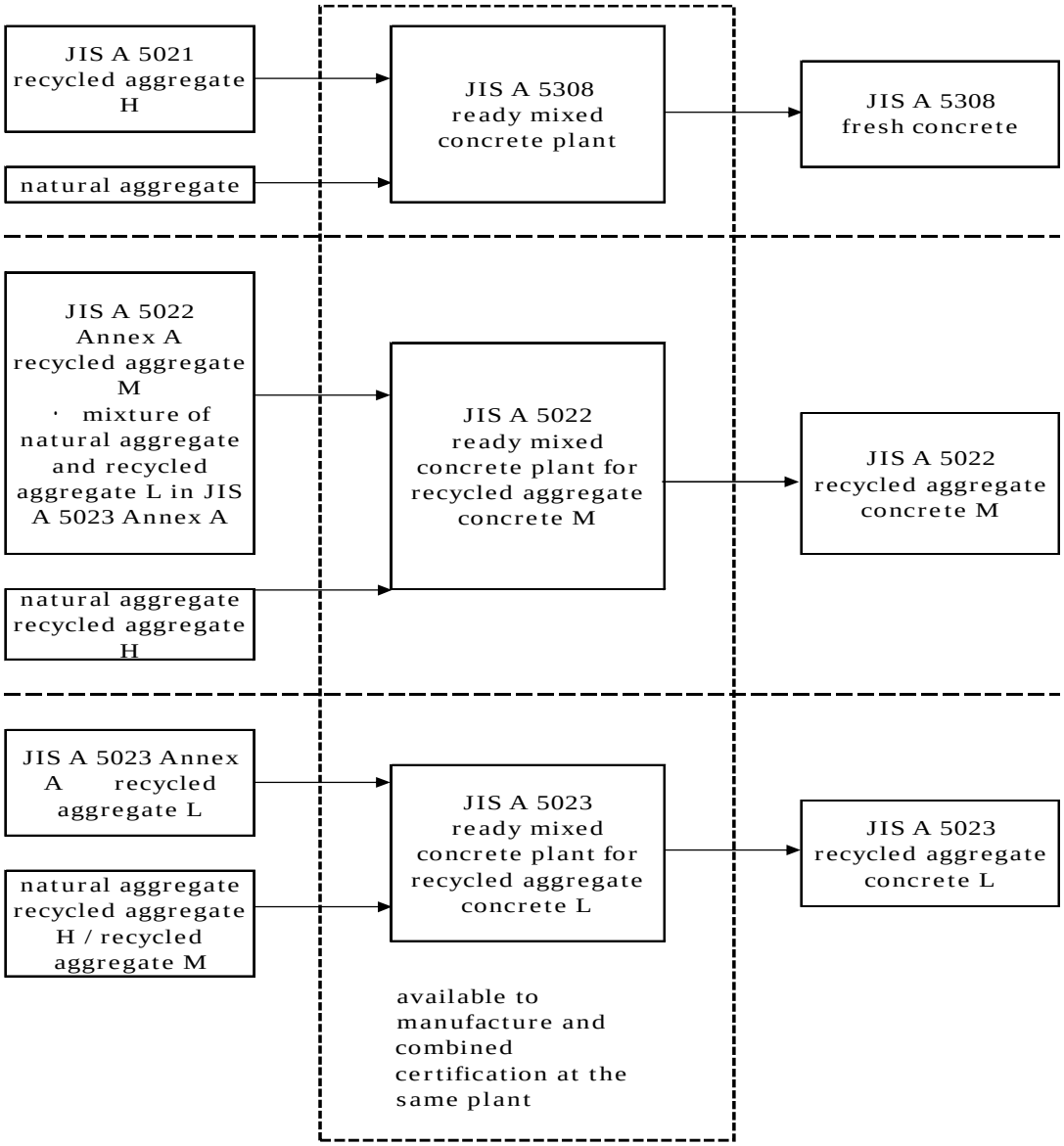
At the time of amendment in 2012, the manufacturer indicated that when testing the chloride content of recycled aggregate by the method specified in Annex A and using young material aged concrete waste such as hardening returned concrete for original concrete, the chloride contents cannot be measured accurately. The addenda were made in 2016, however the topics of discussion such as detailed requirement for adjusting specimens or selection of proper reagent had been remained. As the results of discussion for this amendment, the various test methods are allowed and the analysis method of not using potassium chromate as an indicator is provided.

In former standard the elution amount of chloride contents in recycled aggregate M is calculated by safety factor multiply test value, the manufacturer has requested to reconsider the safety factor based on an actual situation. According to the inspection, the achievement such as test data or scope was judged not enough, and the safety factor is not reconsidered in this amendment.

3.4 Basic point of view for JIS mark certification of recycled aggregate concrete M

In former standard, two situations are anticipated such as the recycled aggregate M is produced at the dedicated plant by the same manufacturer or the recycled aggregate M produced at recycled aggregate plant is transferred to another dedicated plant and manufacture recycled aggregate concrete M. Considering diffusion of recycled aggregate concrete and building its supply system, it has been discussed that the product of JIS A 5022 and JIS A 5023 can be manufactured combined with JIS A 5308 at existing JIS certified plant. Consequently, it was confirmed that the recycled aggregate concrete can be manufactured at existing plant for JIS A 5308 and JIS certification should be also available.

In that case, the company regulations for manufacturing process of JIS A 5308, JIS A 5022 and JIS A 5023 or management method to prevent mixture of concrete and aggregate in relation to the storage of raw materials and transportation should be necessary.



Commentary figure 2 : JIS according to types of recycled aggregate

4. Main revised point

4.1 Scope (clause 1)

According to the relation of the quality of recycled aggregate concrete M and applied member, the concrete using mixture of recycled aggregate L and natural aggregate (except for light-weight aggregate conform to Annex A of JIS A 5308) was sanctioned as recycled aggregate concrete M. However the mixed aggregate shall be satisfied the quality of Annex A of JIS A 5022 and the upper limit of mixture ratio for recycled aggregate L was provided. Moreover for the recycled aggregate L used for a part of aggregate of recycled aggregate concrete M, the amount of impurities and test method shall be satisfied the same requirement as recycled aggregate M and the density shall be tested by the method which is not provided by Annex A of JIS A 5023.

4.2 Classification (clause 4)

Due to the acceptance of mixture usage, the combination of aggregate has been various. Therefore the division according to the combination of aggregates has been provided. In former standard the recycled aggregate M shall be classified standard class and frost damage resistance class and in order to clarify the division of freeze thaw resistance is provided. The conditions for frost damage resistance shall be several and the recycled fine aggregate M shall not be applied for the frost damage resistance due to the resistance workability is not confirmed by test. Moreover according to the report that the workability of freeze thaw resistance shall be weaker if low quality recycled aggregate is mixed, so as the recycled aggregate L shall be exclusive from application for frost damage resistance class.

4.3 Aggregate (8.2)

As described above, the upper limit of the mixture ratio of recycled aggregate L must be set. Considering the required value of absorption for recycled aggregate M and recycled aggregate L, the upper limit shall be 50% for recycled coarse aggregate L and 30% for recycled fine aggregate L.

As same as the former standard, if the aggregate of division B by alkali-silica reactivity test is used a part of the aggregate, whole of the aggregate must be treated as not confirmed as harmless.

Moreover even if the recycled aggregate L is satisfied the requirement of Annex A of JIS A 5023, it cannot be treated as recycled aggregate M. Therefore the condition that amount of impurities and test method for recycled aggregate L also shall be satisfied the requirement of recycled aggregate M is added.

Meanwhile the mixture aggregate of different grain sizes such as recycled coarse aggregate L4020 and natural coarse aggregate 2005 is considered whether it is satisfied the quality of recycled aggregate M. Therefore the condition that the upper limit of volume mixture ratio shall be 50% and the aggregates in various grain size shall not be mixed is designated. For example, same grain size of the recycled coarse aggregate L2005 and natural aggregate 2005 shall be produced first and mixed them for manufacture recycled aggregate concrete M.

4.4 Designation (clause 12)

In former standard, the recycled aggregate concrete M was designated as recycled M1 and recycled M2. Because it was judged that the recycled fine aggregate shall be much effected to the quality of concrete due to the upper limit of absorption of recycled fine aggregate shall be higher as 7.0% than that of recycled coarse aggregate 5.0%. Therefore the recycled aggregate concrete M which using natural aggregate for all the fine aggregate shall be designated as recycled M1 in order to the manufacturers can easy to use by trustworthy of quality and the promotion of recycled aggregates.

By means of this amendment, the aggregates of various divisions shall be used, the combinations of each aggregates and mixture ratio shall be diversify and the combination of aggregates for recycled aggregate concrete M shall be complicated. CT1 shows the example of relative absorption according to the various combination of aggregates. It is found that the quality of mixture aggregates is in the required range due to the upper limit of mixture ratio for recycled coarse aggregate L shall be 50% and for recycled fine aggregate L shall be 30%.

In division according to the combinations of aggregates, the classification of recycled aggregate shall be specified whether the concrete using recycled aggregate M or concrete using the mixture of recycled aggregate L and natural aggregate. As same as the former standard, concrete using mixture of recycled coarse aggregate L and natural coarse aggregate and natural fine aggregate shall be designated as recycled M1.

CT 1 example for combination of aggregates and relative absorption

Division	mixing ratio of coarse aggregate (%)			mixing ratio of fine aggregate (%)			relative absorption (%)		
	recycled aggregate M	recycled aggregate L	natural aggregate	recycled aggregate M	recycled aggregate L	natural aggregate	coarse aggregate	fine aggregate	total aggregate
recycled M2	100	0	0	100	0	0	5.0	7.0	6.0
recycled M2	0	0	100	100	0	0	3.0	7.0	5.0
recycled M2	50	0	50	50	0	50	4.0	5.3	4.6
recycled M1	100	0	0	0	0	100	5.0	3.5	4.3
recycled M1	50	0	50	0	0	100	4.0	3.5	3.8
recycled M2	0	50	50	0	30	70	5.0	6.4	5.7
recycled M2	0	0	100	0	30	70	3.0	6.4	4.7
recycled M2	100	0	0	0	30	70	5.0	6.4	5.7
recycled M2	0	50	50	100	0	0	5.0	7.0	6.0
recycled M1	0	50	50	0	0	100	5.0	3.5	4.3

Note : The absorption of aggregates shall be the upper limit of standard value
Ratio of fine aggregate shall be 50%

4.5 Report (clause 13)

As mentioned above, the recycled aggregate L shall not be used for recycled aggregate concrete M, even if it is satisfied the requirement of Annex A of JIS A 5023,. The mixture aggregate of recycled aggregate L and natural aggregate must have as same quality and must be managed the quality as recycled aggregate M. Therefore the manufacturer of recycled aggregate concrete M shall show the evidence to the purchaser. It was added in the report that if using mixture aggregates, the manufacturer shall submit test result certificate for the quality of the recycled aggregate L given in this standard which is as same level for the recycled aggregate M.

4.6 Recycled aggregate M [Annex A (normative)]

4.6.1 Alkali-silica reactivity (A.3.3)

According to the alkali-silica reactivity of recycled aggregate M, the condition for harmless

has not been changed. The method for specification of original aggregate which manufacturer of recycled aggregate can carry out was added in Annex A of JIS A 5021 (Recycled aggregate for concrete-class H). Thus for recycled aggregate M, the original aggregate can be specified by sampling the original concrete at unloading site.

4.6.2 Test for Chloride content (A.5.10)

In former standard, chloride content test for recycled aggregate shall be given in 5.5 in JIS A 5002. However when young aged concrete waste such as hardened return concrete is used as original concrete, the exact measurement of chloride content is difficult due to the effect of strong alkali of sample solution. At the additional amendment in April 2016, the pH of extracted supernatant shall be allowed to adjust 7 in case interfering ion effects.

Moreover in this amendment, the test method given in JIS A 1154 (Methods of test for chloride ion content in hardened concrete) which adjust pH in advance can be used. In this method, the recycled aggregate is used instead of hardened concrete, 300g of recycled fine aggregate and 2kg of recycled coarse aggregate shall be sampled as specimens. Thus this test result shows the whole content of chloride ion (CI^-) of recycled aggregate M including adhered paste, the test result is no need to be four times.

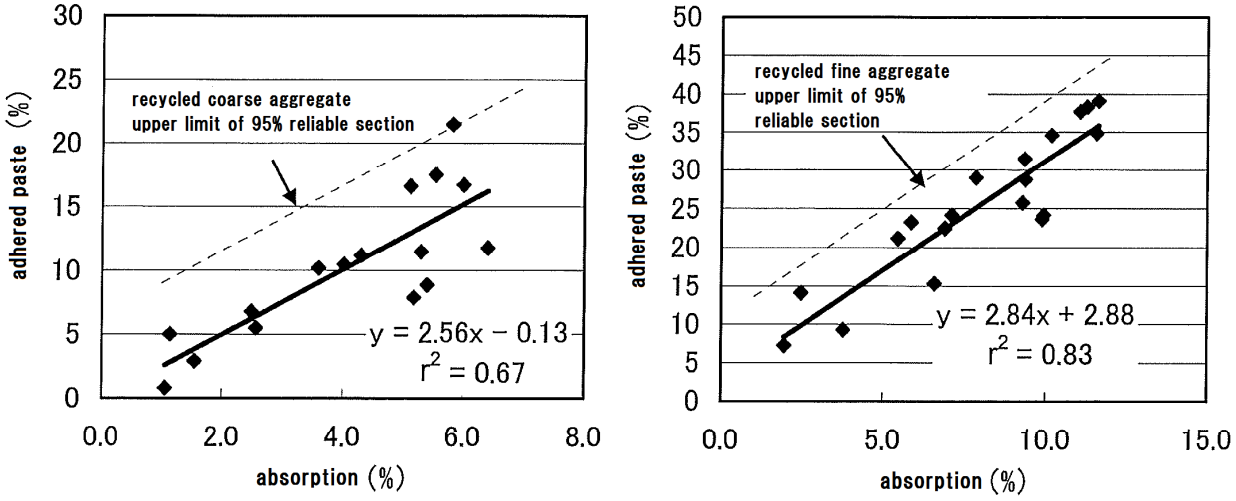
Meanwhile, in the former standard silver nitrate titration which potassium chromate is an indicator was regulated as the test method in 5.5 of JIS A 5002. The potassium chromate is designated as a deleterious substance by Poisonous and Deleterious Substances Control Act and a target substance of Ordinance on Prevention of Hazards Due to Specified Chemical Substances in Industrial Safety and Health Act, it should be handled strict for an indicator. Therefore the measurement of chloride ion concentration in sampling solution shall be changed to carry out in clause 4 (analysis method) of JIS A 1144 (Method of test for chloride concentration in water of fresh concrete). According to JIS A 1144, absorption spectrophotometry and potentiometric titration shall be added for test method.

4.7 Method of countermeasure for restraint alkali-silica reactivity for recycled aggregate concrete M in Annex C (normative)

The countermeasure for restraint alkali-silica reactivity shall be an important issue for recycled aggregate concrete M because it will be mainly used for underground structure which effected by water. To enlarge the use of recycled aggregate concrete M, five methods shall be given in this countermeasure, and well considered for this amendment.

In former standard, the method of restriction total amount of alkali in recycled aggregate M was given. In this method the total amount of alkali in aggregate must be calculated by test however it is impractical for the time and costs. According to the commentary figure 3, the relation between absorption and adhered cement paste of recycled aggregate shall be calculated, placing alkali amount of adhered cement paste on safety side, the total amount of alkali shall be

calculated as follows.



Commentary figure 3

Relations between absorption and adhered paste of recycled aggregate

a) The total amount of alkali in recycled coarse aggregate M shall be calculated by the following formula to the second decimal place. However, maximum value of total amount of alkali in recycled coarse aggregate M shall be 0.20%.

$$r_{rg} = 0.025 \times Q_{rg} + 0.075$$
$$Q_{rg} = {}_a Q_{rg} + 1.64\sigma$$

where, r_{rg} : total amount of alkali in recycled coarse aggregate M (%)
Q_{rg} : water absorption of recycled coarse aggregate (%)
${}_aQ_{rg}$: mean value of absorption for recycled coarse aggregate M manufactured in the past (%)
σ : standard deviation (%)

b) The total amount of alkali in recycled fine aggregate M shall be calculated by the following formula to the second decimal place. However, maximum value of total amount of alkali in recycled fine aggregate M shall be 0.30%.

$$r_{rs} = 0.033 \times Q_{rs} + 0.067$$
$$Q_{rs} = {}_a Q_{rs} + 1.64\sigma$$

where, r_{rs} : total amount of alkali in recycled fine aggregate M (%)
Q_{rs} : water absorption of recycled fine aggregate (%)
${}_aQ_{rs}$: mean value of water absorption for recycled fine aggregate M manufacturing in the past (%)
σ : standard deviation (%)

According to the commentary figure 3, the recycled aggregate L is included in the data. Therefore in the formula above the recycled aggregate L is allowed to use the method in the former standard. However the upper limit of absorption for recycled aggregate M and L is various, the maximum value of total alkali amount for recycled coarse aggregate L shall be 0.25%, for recycled fine aggregate L shall be 0.50%.