ACRAC Course of Lectures for Technical Qualifying

JIS A 5022 Amendment Point of JIS for Recycled Aggregate for Concrete-class M

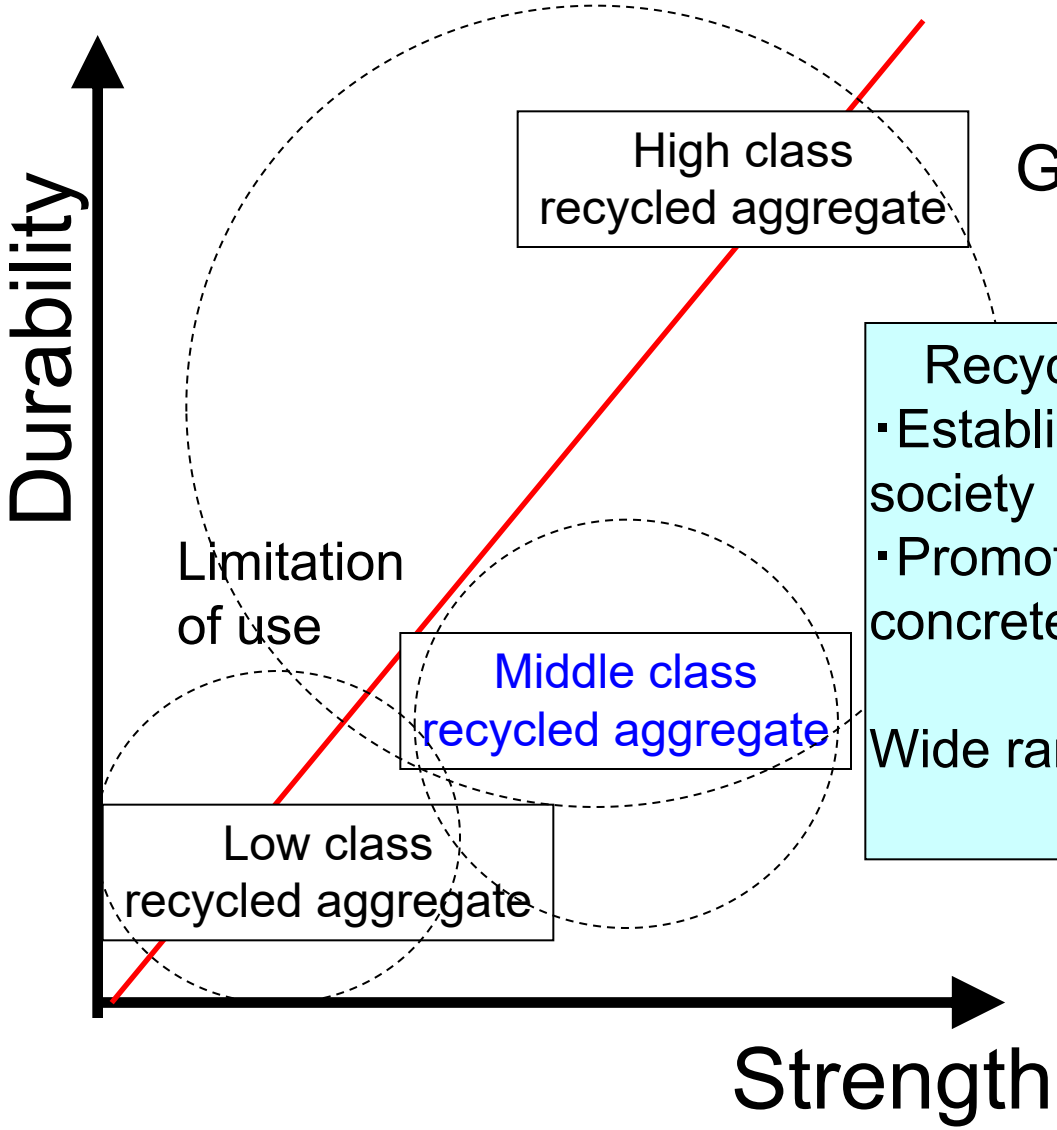
Prof. Akio Koyama

Meiji University

明治大学
MEIJI UNIVERSITY

Details of standardized recycled aggregate concrete

Policy of recycled aggregate concrete for JIS



Recycled aggregate concrete for JIS

- Establishing sound-material cycle society
- Promotion of recycled aggregate concrete

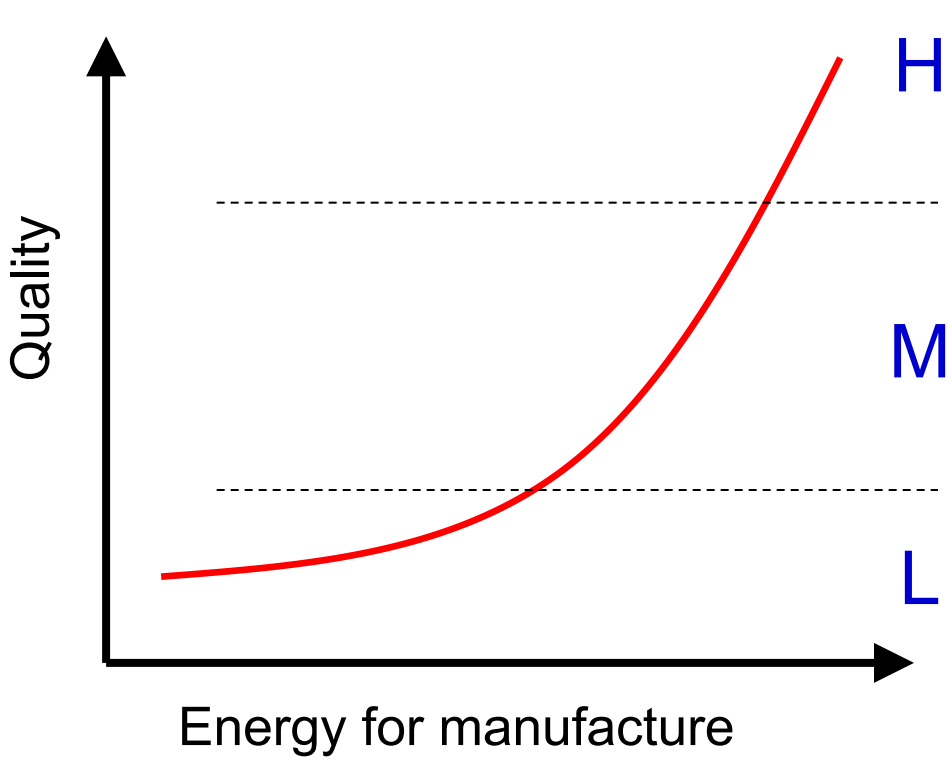
Wide range of options (menu)

Details of standardized recycled aggregate concrete

From aggregate for road bed material to aggregate for concrete structure

Utilization method

Method of manufacturing aggregate



H
- Pick out only aggregate
- Use less dense（10%）

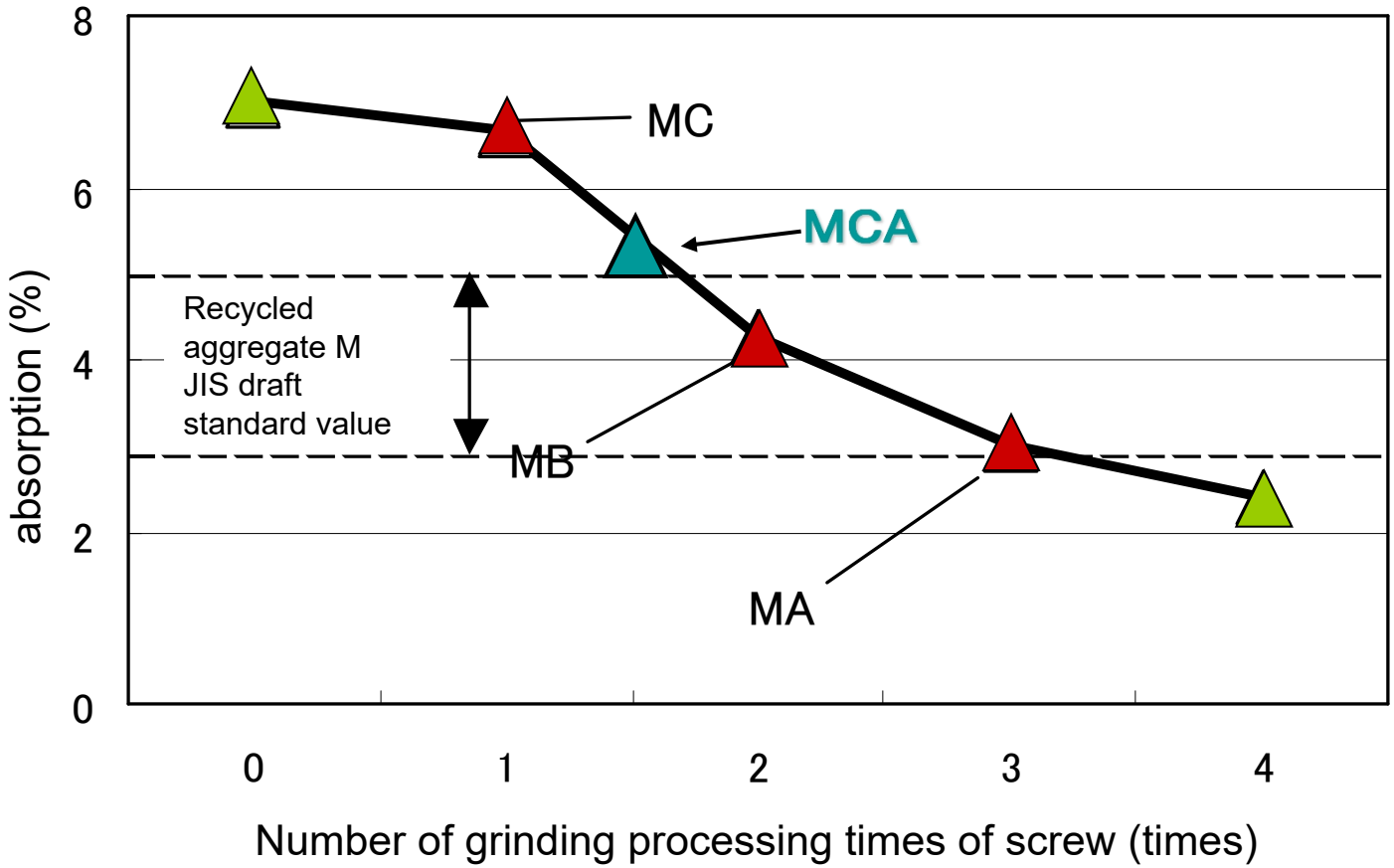
M
- Use less dense（30～50%）
- Limitation of use
  （underground structure）

L
- Low class aggregate（100%）
- Limitation of use
  （nonstructure）

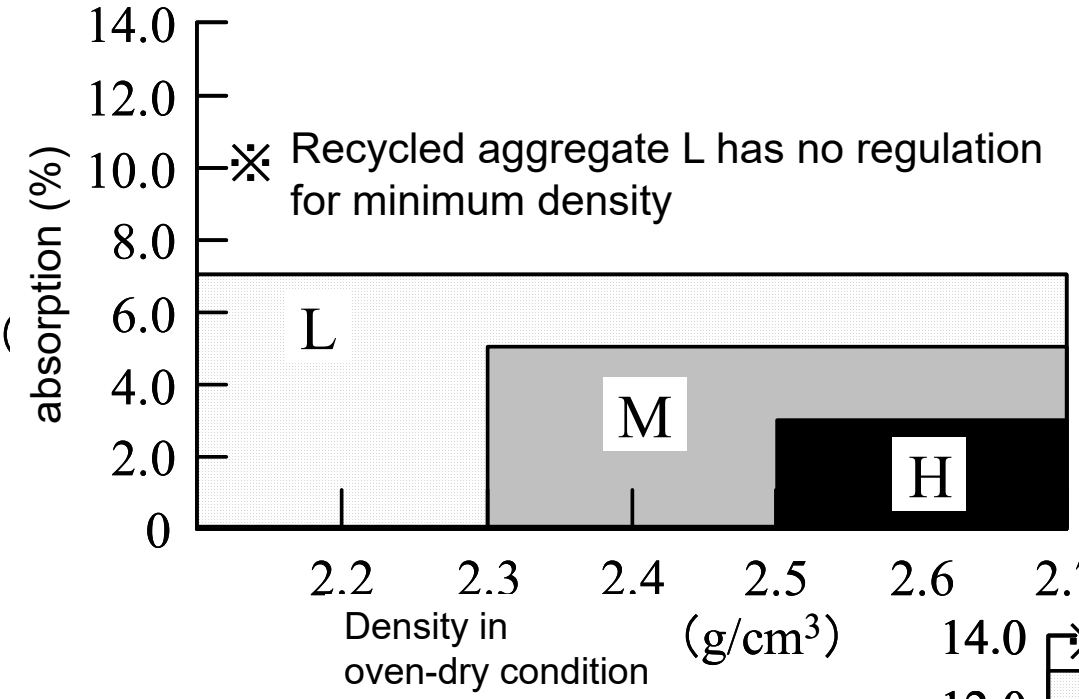
Details of standardized recycled aggregate concrete

ex）relations between a number of grinding processing times and absorption

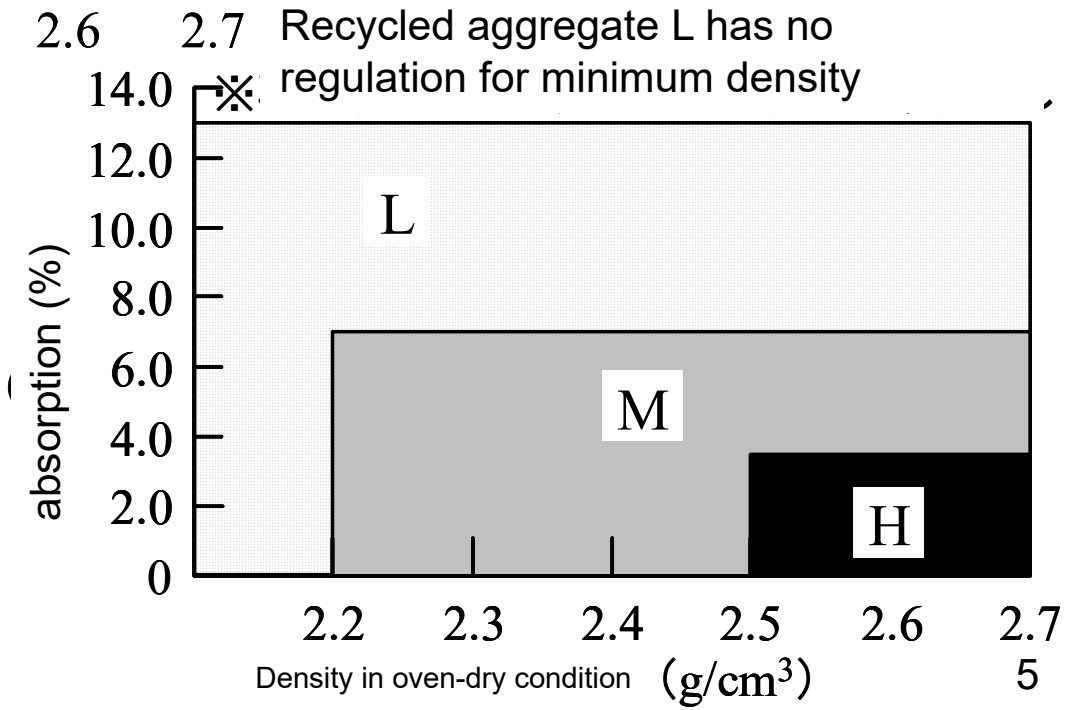
Recycled aggregate L ⇒ M ⇒ H



Overview of standard for recycled aggregate concrete



Types and quality of recycled aggregate

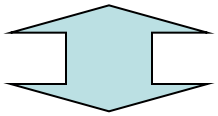


Overview of standard for recycled aggregate concrete

Types of recycled aggregate and intended use of concrete

		recycled aggregate H	recycled aggregate M	recycled aggregate L
Quality of aggregate (absorption)	coarse aggregate	under 3.0%	under 5%	under 7%
	fine aggregate	under 3.5%	under 7%	under 13%
mainly intended use		with nonpaticular limit (assuming as same usage as JIS A 5308)	structural menber for less damaged by dry shrinkage or freeze thaw such as pile, pressure resisting slab, footing beam or filling steal pipe concrete	member for high strength or high durability shall not be required
nominal strength		assumed 18 to 45 (will be required in JIS A 5308)	18 to 36	standard product : 18 upper limit of specification ordering product : 24
Variety of JIS standard		standard for aggregate	standard for concrete	standard for concrete
publication		JIS A 5021 March 2005	JIS A 5022 March 2007	JIS A 5023 March 2006

Quality range of recycled aggregate



Intended use of recycled aggregate concrete

5021 : 2011 amendment
5022・5023 : 2012 amendment

Framing of JIS A 5022

1)Substance
2)Annex
A standard for recycled aggregate M
B Method of manufacturing recycled aggregate concrete M
C Method of countermeasure alkali-silica reactivity for recycled aggregate concrete M
D Method of test for freeze thaw of recycled coarse aggregate M

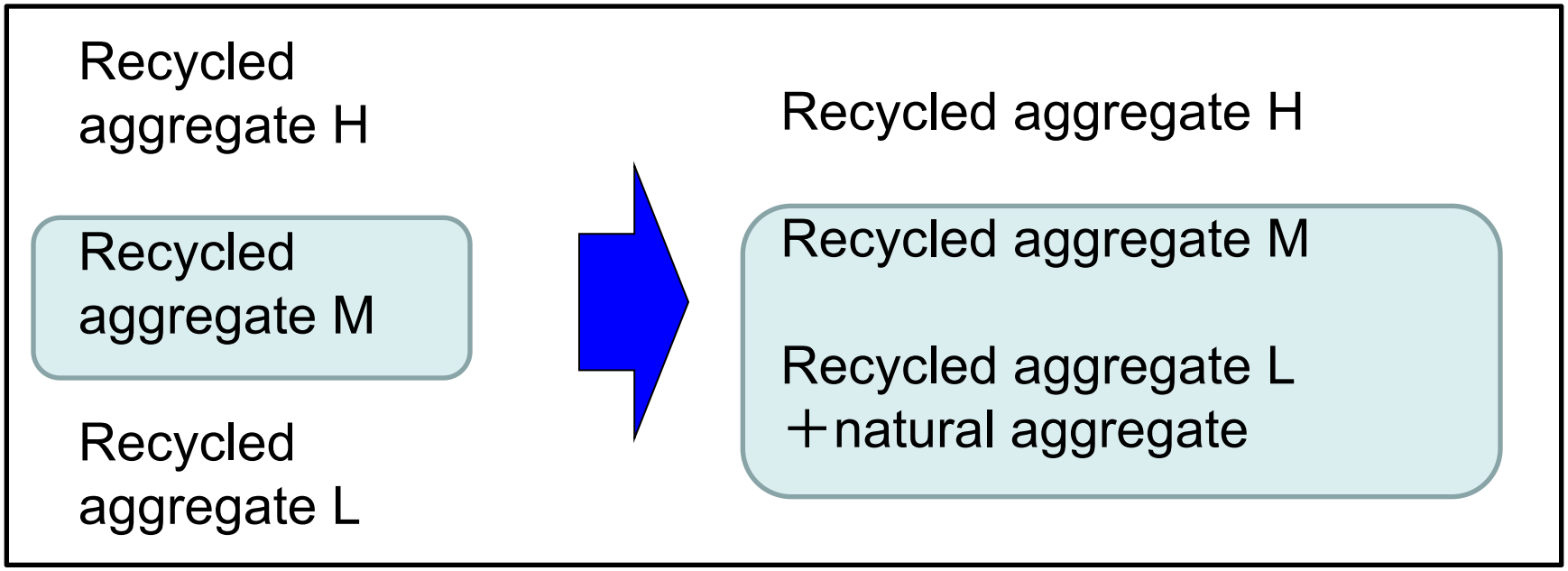
※Product of frost damage resistance has been added since amendment in 2012

Amendment point of JIS A 5022

Change the name of the standard

JIS A 5022（Concrete using recycled aggregate class M）

JIS A 5022（Recycled aggregate concrete class M）



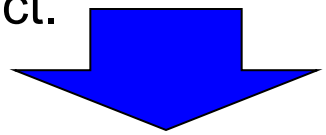
Amendment point of JIS A 5022

Scope of application for standard established in 2007

This standard specifies the recycled aggregate for concrete class-M and the concrete using the recycled aggregate M partly or whole of the aggregate manufactured by the concrete lumps generated as a result, for example, of pulling down a building through crushing, grinding or segregating process.

Note: The intended use for recycled aggregate concrete class M is assumed for the member of less damaged by dry-shrinkage or freeze-thaw.

In 2012 edition, the variety was specified between standard product and frost damage resistance product.



In this amendment, the intended use has not been changed.

Amendment point of JIS A 5022

Scope of application at this amendment for standard

This standard specifies the recycled aggregate for concrete class-M [1)] . However this standard is not applied to the transportation after delivery and pouring and curing.
While comparison table between current and previous editions of this Standard on technically significant revisions shall be shown in Annex E.

Note1) Regarding the recycled aggregate concrete class-M, the concrete using recycled aggregate for concrete class-M (hereafter referred to as “recycled aggregate concrete M”) conforming to Annex A and the mixture concrete of recycled aggregate for concrete class-L (hereafter referred to as “recycled aggregate concrete L”) conforming to Annex A in JIS A 5023 and natural aggregate shall be specified.

Amendment point of JIS A 5022

Reason for expand the scope of application at this amendment for standard

- It was proved that even low class recycled aggregate shall be ensured the quality for concrete when using mixture with natural aggregate by the result of several research.
- When the recycled aggregate L is mixed with natural aggregate, depends on the mixture ratio, the quality is believed to satisfy the quality of recycled aggregate M.

Relative absorption（weighted average of absorption for aggregate）

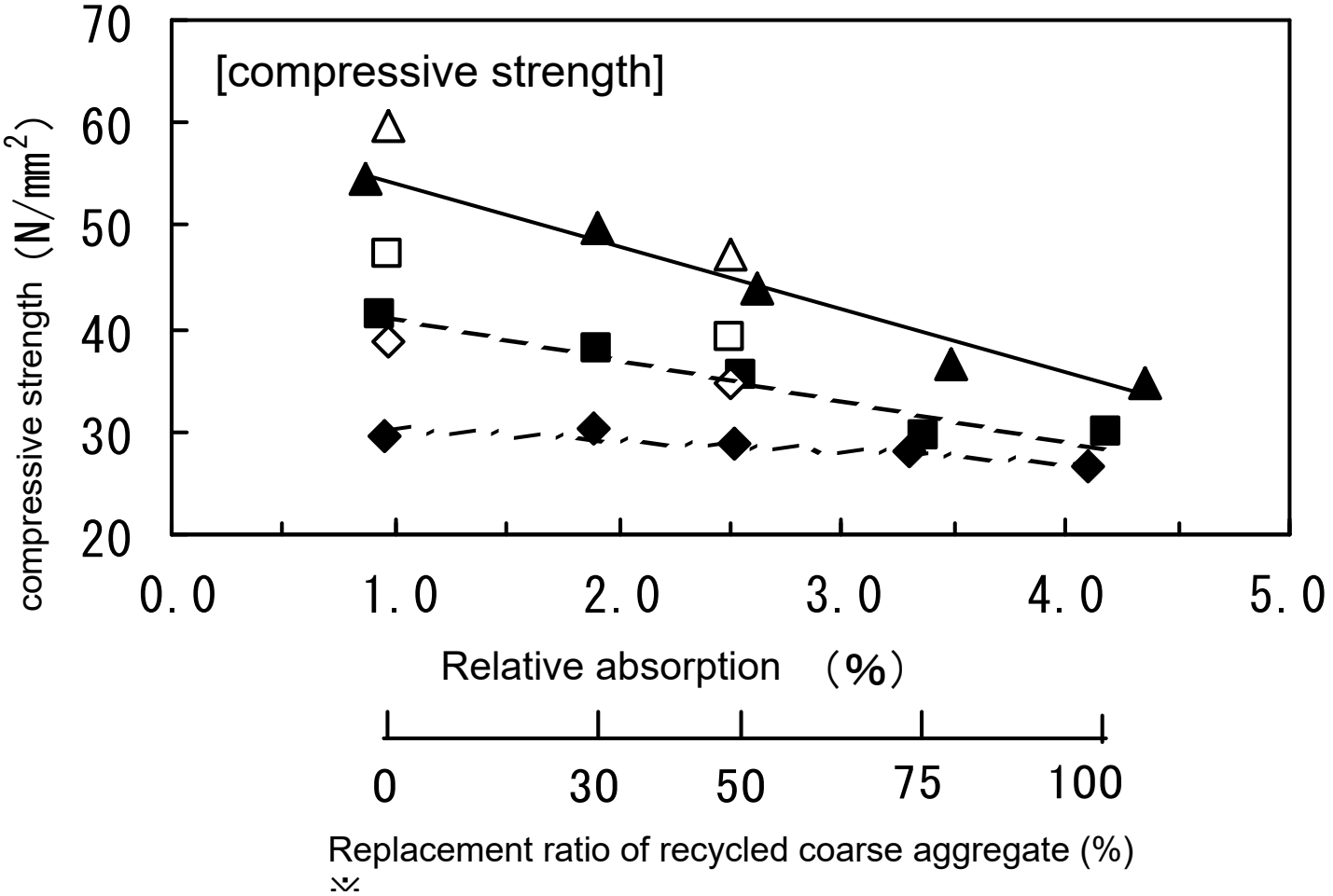
$$Q_t = \frac{Q_v G \times a + Q_r G \times b + Q_v N \times c + Q_r N \times d}{a + b + c + d}$$

where,

- Q_t: Relative absorption of aggregate（%）
- Q_vG: Absorption of natural coarse aggregate（%）
- Q_vN: Absorption of natural fine aggregate（%）
- Q_rG: Absorption of recycled coarse aggregate（%）
- Q_rN: Absorption of recycled fine aggregate（%）
- a, b, c, d: Absolute volume for each aggregate（L/m^3）

Amendment point of JIS A 5022

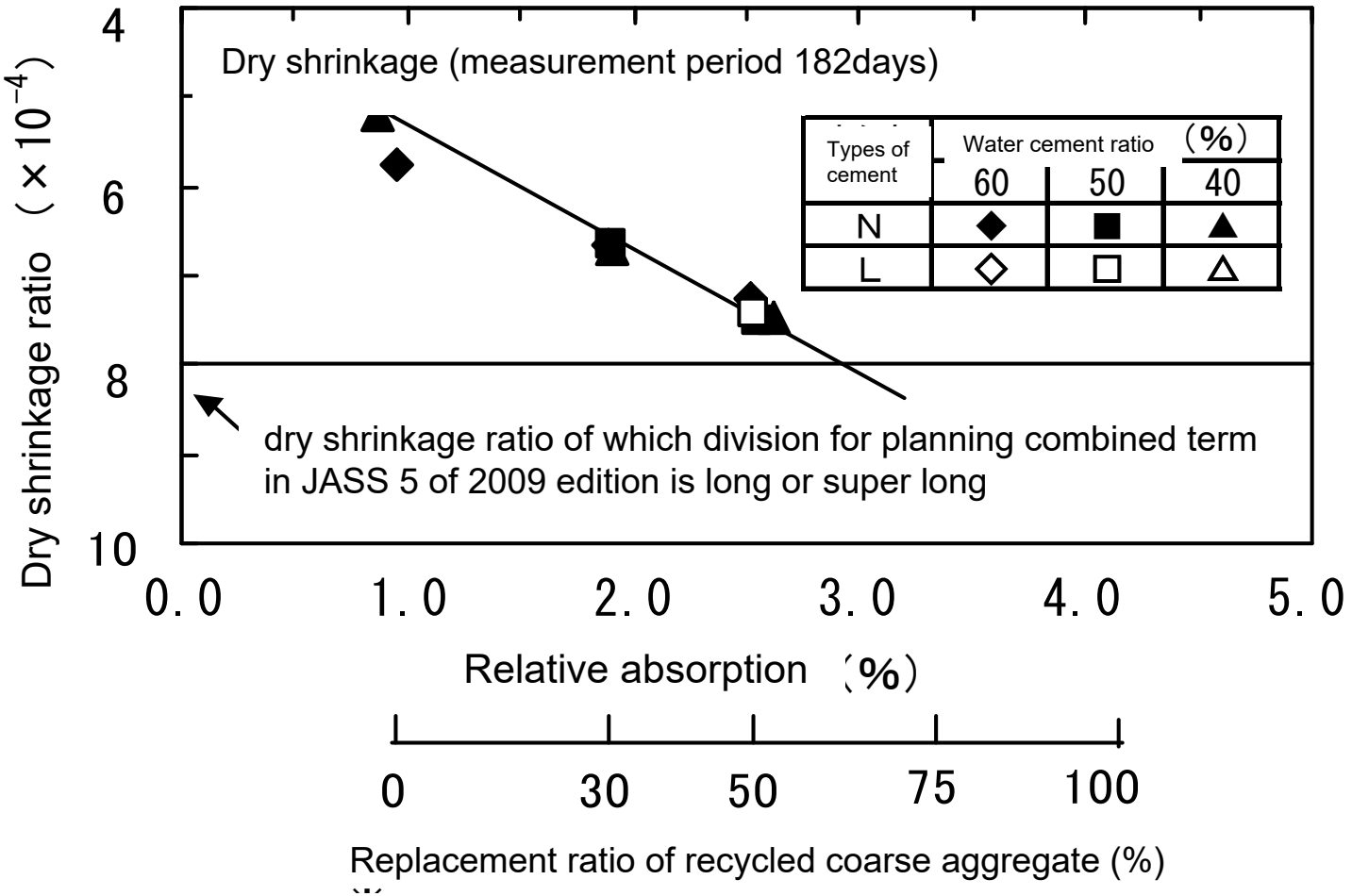
Relation between relative absorption and each properties of recycled aggregate concrete



※the replacement ratio shown in here shall be in accordance with preparation of N, W/C=50%

Amendment point of JIS A 5022

Relation between relative absorption and each properties of recycled aggregate concrete



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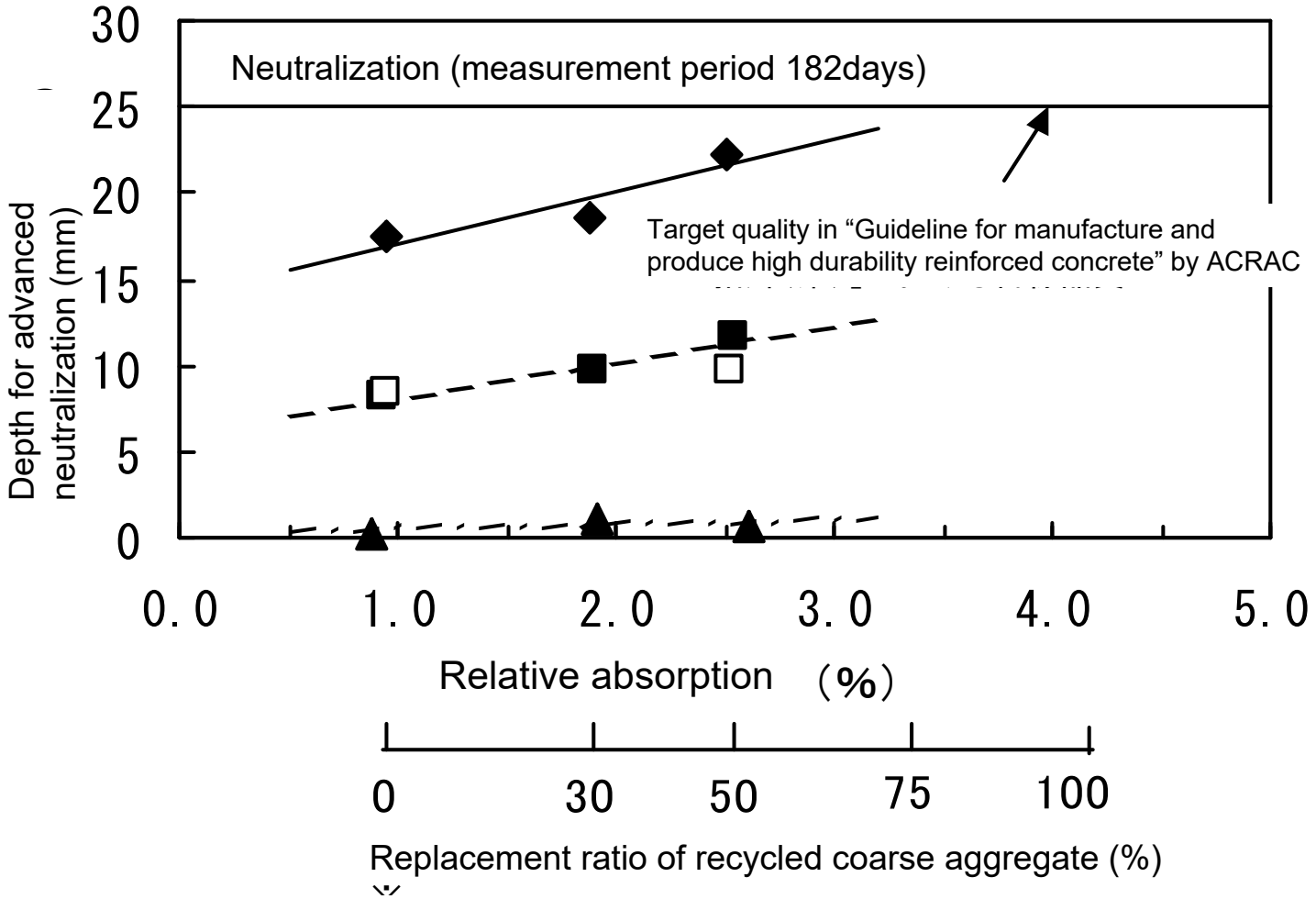
Amendment point of JIS A 5022

Relation between relative absorption and each properties of recycled aggregate concrete



※the replacement ratio shown in here shall be in accordance with preparation of N, W/C=50%

Ref. Technical report of Architectural Institute of Japan No.21, pp.15-20, 2005.June

Amendment point of JIS A 5022

Notice point for scope of application in this amendment

- The mixture aggregate shall be satisfied the quality of Annex A in JIS A 5022, and an upper limit for mixture ratio of recycled aggregate L shall be settled.
- The recycled aggregate L for using a part of aggregate of recycled aggregate concrete M shall be satisfied not only the requirement of Annex A in JIS A 5023 but also for amount of impurities and inspection method, satisfied the same requirement of recycled aggregate M. Moreover for its density, test which is not provided in Annex A in JIS A 5023 needs to be carried out.

The recycled aggregate L for concrete has been eased for specified value and managing method compared to recycled aggregate M.

Amendment point of JIS A 5022

Changes for classification in this amendment

- Due to the mixture of recycled aggregate L and natural aggregate shall be admitted as recycled aggregate concrete M, the combination of aggregate was diversified.
- In former standard, classification of recycled aggregate M has standard class and frost damage resistance class conform to the member or the part affected by freeze thaw. In order to make clear of that, the division for freeze thaw resistance shall be settled.

4 Classification

4.1 Division according to combination of aggregate

4.2 Division according to freeze thaw resistance

4.3 Maximum size, slump and nominal strength of coarse aggregate

4.4 Specification and agenda

Table1－ Division according to combination of aggregate

Division according to combination of aggregate	Coarse aggregate	Fine aggregate
Recycled aggregate M type 1	The coarse aggregate produced by one of the followings. a) All of the coarse aggregate is recycled coarse aggregate M. b)The mixture of recycled coarse aggregate M and coarse aggregate 1) conform to Annex A in JIS A 5308 c)The mixture of recycled coarse aggregate L and coarse aggregate 1) conform to Annex A in JIS A 5308	All of the fine aggregate 1) conforme to Annex A in JIS A 5308
Recycled aggregate M type 2	The coarse aggregate produced by one of the followings. a) All of the coarse aggregate is recycled coarse aggregate M. b)The mixture of recycled coarse aggregate M and coarse aggregate 1) conform to Annex A in JIS A 5308 c)The mixture of recycled coarse aggregate L and coarse aggregate 1) conform to Annex A in JIS A 5308 d)All of the coarse aggregate is conformed to Annex A in JIS A 5308.	The fine aggregate produced by one of the followings. a) All of the fine aggregate is recycled fine aggregate M. b)The mixture of recycled fine aggregate M and fine aggregate 1) conform to Annex A in JIS A 5308 c)The mixture 2) of recycled fine aggregate L and fine aggregate 1) conform to Annex A in JIS A 5308

Note 1) Exclude the artificial lightweight aggregate in the aggregate conform to Annex A in JIS A 5308(Aggregate for ready mixed concrete)
2) The mixed aggregate shall be satisfied the quality of Annex A

4.2 Division according to freeze thaw resistance

Division according to freeze thaw resistance shall be as follows.

a) Standard class[2)]

Recycled aggregate concrete M which is not specified the character for freeze thaw resistance and drying shrinkage.

b) Frost damage resistance class[3)]

The recycled aggregate concrete M with efficiency of freeze thaw resistance and shall be satisfied with all of following requirements.

Note 2) standard class may be used for the member or part which less subject to dry shrinkage or freeze thaw.

3) frost damage resistance class may be used for the member or part which less subject to dry shrinkage but affected by freeze thaw.

4.3 Maximum size, slump and nominal strength of coarse aggregate

Maximum size, slump and nominal strength of coarse aggregate shall be shown in Table 2.

Table2－ Maximum size, slump and nominal strength of coarse aggregate

Division according to freeze thaw resistance	Maximum size of coarse aggregate mm	Slump [a] cm	Nominal strength						
			18	21	24	27	30	33	36
Standard class	20, 25	8, 10, 12, 15, 18	○	○	○	○	○	○	○
		21	－	○	○	○	○	○	○
	40	5, 8, 10, 12, 15	○	○	○	○	○	－	－
Frost damage resistance class	20, 25	8, 10, 12, 15, 18, 21	－	－	－	○	○	○	○

Note [a] the value at unloading site

Amendment point of JIS A 5022

Following items shall not be changed.

5 Quality
- 5.1 Compressive strength, slump and air content
- 5.2 Chloride content
- 5.3 Countermeasure for restraint alkali-silica reactivity

6 Volume

7 Mix proportion

8 Materials
- 8.1 Cement
- 8.3 Water
- 8.4 Admixture

Amendment point of JIS A 5022

Changes for materials (aggregate) in this amendment

- The upper limit of recycled coarse aggregate L shall be 50% and recycled fine aggregate L shall be 30% with considering required value of absorption for recycled aggregate M and recycled aggregate L to ensure the quality of mixed aggregate.
- Due to increase the variety of recycled aggregate may be used, it is said “When mixing a part of aggregate of Division B by alkali–silica reactivity test, the whole of aggregate must be treated as the aggregate which is not confirmed harmless”. While this is as same as former standard.
- For recycled aggregate L, the condition shall be even the quality after mixture is satisfied the quality of recycled aggregate M also recycled aggregate L itself shall be satisfied the requirement of recycled aggregate M for content of impurities and inspection method.

Upper limit of mixture ratio of recycled aggregate L

classifications	Mix ratio of coarse aggregate (%)			Mix ratio of fine aggregate (%)			Relative absorption (%)		
	M	L	Natural	M	L	Natural	Coarse aggregate	Fine aggregate	Whole of aggregate
RA M type 2	100	0	0	100	0	0	5.0	7.0	6.0
RA M type 2	0	0	100	100	0	0	3.0	7.0	5.0
RA M type 2	50	0	50	50	0	50	4.0	5.3	4.6
RA M type 1	100	0	0	0	0	100	5.0	3.5	4.3
RA M type 1	50	0	50	0	0	100	4.0	3.5	3.8
RA M type 2	0	50	50	0	30	70	5.0	6.4	5.7
RA M type 2	0	0	100	0	30	70	3.0	6.4	4.7
RA M type 2	100	0	0	0	30	70	5.0	6.4	5.7
RA M type 2	0	50	50	100	0	0	5.0	7.0	6.0
RA M type 1	0	50	50	0	0	100	5.0	3.5	4.3

※1 For absorption of aggregate, upper limit of specified value was settled

※2 In case the ratio of fine aggregate is 50%

Amendment point of JIS A 5022

8.2 Aggregate

Aggregate shall be as follows.

a) Coarse aggregate shall be used either of the followings.

1) Recycled coarse aggregate M shall be used independently or used by mixture with coarse aggregate conform to Annex A in JIS A 5308.

2) Recycled coarse aggregate L shall be used by mixture with coarse aggregate conform to Annex A in JIS A 5308. Therefore the upper limit of volume mixture ratio of recycled coarse aggregate shall be 50 %.

b) Fine aggregate shall be used either of the followings.

1) Recycled fine aggregate M shall be used independently or used by mixture with fine aggregate conform to Annex A in JIS A 5308.

2) Recycled fine aggregate L shall be used by mixture with fine aggregate conform to Annex A in JIS A 5308. Therefore the upper limit of volume mixture ratio of recycled fine aggregate shall be 50 %.

Amendment point of JIS A 5022

8.2 Aggregate（continued）

c) When mixing a part of aggregate of Division B by alkali-silica reactivity test, the whole of the aggregate shall be treated as not confirmed harmless.

d) Recycled aggregate L shall be given in the requirement of Annex A in JIS A 5023 and following requirement.

1) The content of impurities of recycled aggregate L shall be satisfied the requirement of A.3.1.

2) When using recycled aggregate L by mixture with aggregate of Annex A in JIS A 5308, the physical character, grain size, grain shape and chloride content shall be satisfied the requirement of A.3 after mixture.

3) The inspection method of recycled aggregate L shall be satisfied the requirement of A.6.1.

e) When using recycled aggregate by mixture with the aggregate conform to Annex A in JIS A 5308, the mixture in advance shall not be used.

Amendment point of JIS A 5022

Changes for “9. Method of manufacture” in this amendment

B.4 Measuring of materials

B.4.1 Measuring method

The measuring method of materials shall be as follows.

a) The cement, aggregate, water and admixture shall be measured by each own measuring device. However the water may accumulate with chemical admixture measuring beforehand.

b) The cement, aggregates and admixture shall be measured according to mass. The admixture may be calculated by amount of bags with approval by the purchaser. However if measuring amount less than one bag, it shall be measured by mass.

c) The water and chemical admixture shall be measured according to mass or volume.

d) When using recycled aggregate by mixture with aggregate conform to Annex A in JIS A 5308, the aggregate shall be measured by types.

Amendment point of JIS A 5022

Following items shall not be changed.

10 Test Method

- 10.1 Method of sampling of specimen
- 10.2 Test for compressive strength
- 10.3 Slump
- 10.4 Air content
- 10.5 Chloride content
- 10.6 Volume

11 Inspection

- 11.1 Inspection items
- 11.2 Compressive strength
- 11.3 Slump and air content
- 11.4 Chloride content
- 11.5 Designated matters

Amendment point of JIS A 5022

Changes for designation in this amendment

12 Designation

The recycled aggregate concrete M shall be designated by sign according to division for the combination of aggregate, division for freeze-thaw resistance, nominal strength, slump, maximum size of coarse aggregate and types of cement.

The sign according to types of cement shall be given in table 5.

ex1 RA M type 1 Frost damage resistance 27 18 20 N

ex2 RA M type 2 standard 24 8 25 BB

Division according to combination of aggregate	Division according to freeze thaw resistance	Nominal strength	Slump (cm)	Maximum size of coarse aggregate (mm)	Sign according to types of cement

Amendment point of JIS A 5022

Changes for designation in this amendment (unsettled)

13 Report

13.1 Designing mix proportion and basic materials of recycled aggregate concrete M

The manufacturer shall present the designing mix proportion of recycled aggregate concrete M (Table 6) shown in Clause 7 b) to the purchaser prior to delivery. The form of designing mix proportion of recycled aggregate concrete M shall be given in Table 6, however description spaces for aggregate or admixture may be changed as increasing or decreasing. While if volume mixture ratio of recycled aggregate is specified by the purchaser, it cannot be eliminated. Moreover according to the request by the purchaser, the manufacturer shall present the materials which shall be the base for the designing mix proportion shown in Clause 7 c).

Recycled aggregate L shall be tested for the quality required in A.3 and the test report required by A.8 shall be presented.

When using sludge water, the manufacturer shall present management report of sludge water in accordance with C.6.3 of JIS A 5308 if requested by the purchaser.

Amendment point of JIS A 5022

Changes for designation in this amendment (unsettled)

13 Report (continued)

13.2 Statement of delivery for recycled aggregate concrete M

The manufacturer shall present the statement of delivery for recycled aggregate concrete M to the purchaser by each carrier at each delivery. The standard format of the statement of delivery shall be shown in Table 7. Therefore the form of statement of delivery may be accepted of which describe as same information as Table 7.

- When using recycled aggregate L mixed with natural aggregate, the mixture shall be as same quality as recycled aggregate M and the quality management of recycled aggregate L shall be same level as recycled aggregate M. The manufacturer of recycled aggregate concrete M must be shown the evidence to the purchaser.
- In JIS A 5022 and 5023, the form of the designing mix proportion is different from JIS A 5308. It is because the important information specified for recycled aggregate (such as volume mixture ratio of recycled aggregate) shall not be missed.

  However for the manufacturer, it is to be desired that can be managed without any big change of the systems.

Amendment point of JIS A 5022

Changes for Annex A (recycled aggregate M) in this amendment

Alkali-silica reactivity (A.3.3)

- For alkali-silica reactivity of recycled aggregate M, the condition in case of harmless shall not be changed. However the specification method of original aggregate which even the manufacturer of recycled aggregate can be managed was added in Annex A (specification method for original aggregate) in JIS A 5021(recycled aggregate for concrete class H).
- Therefore, for recycled aggregate M, the original aggregate shall be specified at unloading site of concrete mass by sampling from original concrete.

Amendment point of JIS A 5022

Changes for Annex A (recycled aggregate M) in this amendment

Test of chloride content（A.5.10）

- The test of chloride content shall be given in 5.5 in JIS A 5002 (Chloride) in present standard, when using young aged concrete mass which hardened the returned concrete as original concrete, due to the influence of strong alkali in liquid of specimen extracted by chloride, the measuring exact amount of chloride content was difficult, if any influence by disturbance of ion is happened, the pH of extracted supernatant may be adjusted about 7.
- Moreover, in this amendment, for the test method of chloride content in recycled aggregate, the method in JIS A 1154 (Test method for chloride ion including hardened concrete) which required the adjustment of pH beforehand shall be used.

Amendment point of JIS A 5022

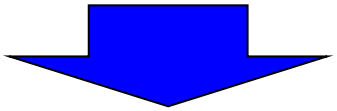
Changes for Annex A (recycled aggregate M) in this amendment

Test for chloride content（A.5.10）

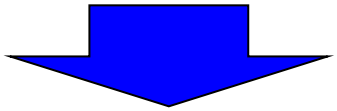
- The test method given in 5.5 of JIS A 5002 in present standard, silver nitrate titration which potassium chromate as to be an indicator has been provided. The potassium chromate is specified deleterious substance by “Poisonous and Deleterious Substance Control Act” and a target substance of Specific chemical substances obstacle prevention law in Industrial Safety and Health Act therefore the handling as an indicator should be strict. While the measurement of density of chloride ion in liquid of specimen shall be changed to carry out according to Clause 4 (analyzing method) in JIS A 1144 (Test method for density of chloride ion in the water of fresh concrete).
- In present standard, the analyzing method is only silver nitrate titration given in JIS A 5002, however absorption spectrophotometry and potentiometric titration given in JIS A 1144 was added.

Amendment point of JIS A 5022

※According to the test for density of chloride ion in the water of fresh concrete, eluted chloride in the mixing water instantly shall be only 1/4 of total chloride ion content. Therefore assuming in the water of fresh concrete 1/4 of total chloride ion content of cement and total chloride ion content of recycled aggregate M shall be eluted, the chloride content in the recycled aggregate concrete M shall be calculated.



While the ratio for recycled aggregate H shall be 3/4 and for recycled aggregate L shall be four times, is it possible to reconsider the ratio for recycled aggregate M?



After the inspection or test for variability of chloride content test value using recycled aggregate L and M which manufactured by the factory of ACRAC member, we have decided that more data will be needed for the amendment of the requirement.

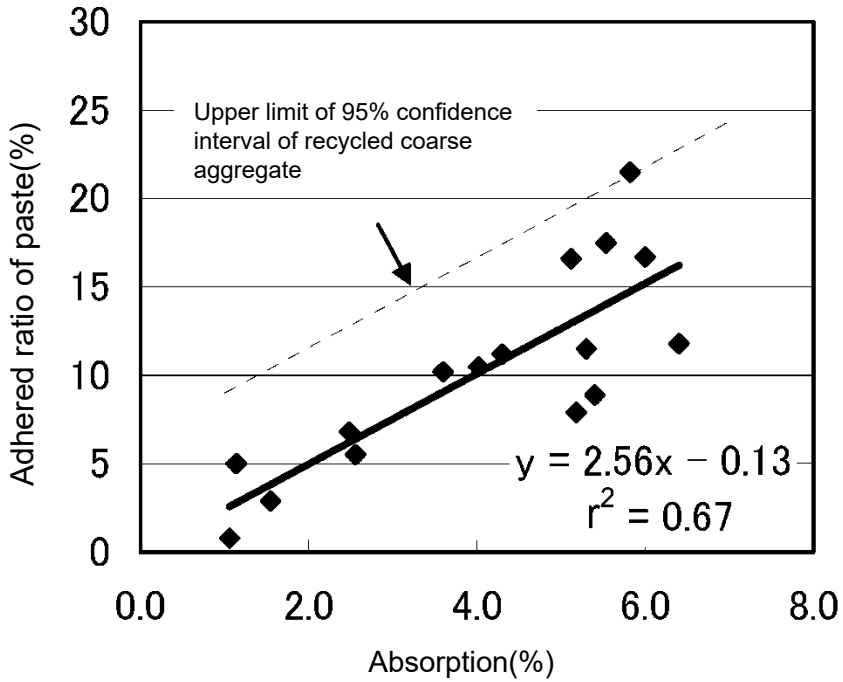
Amendment point of JIS A 5022

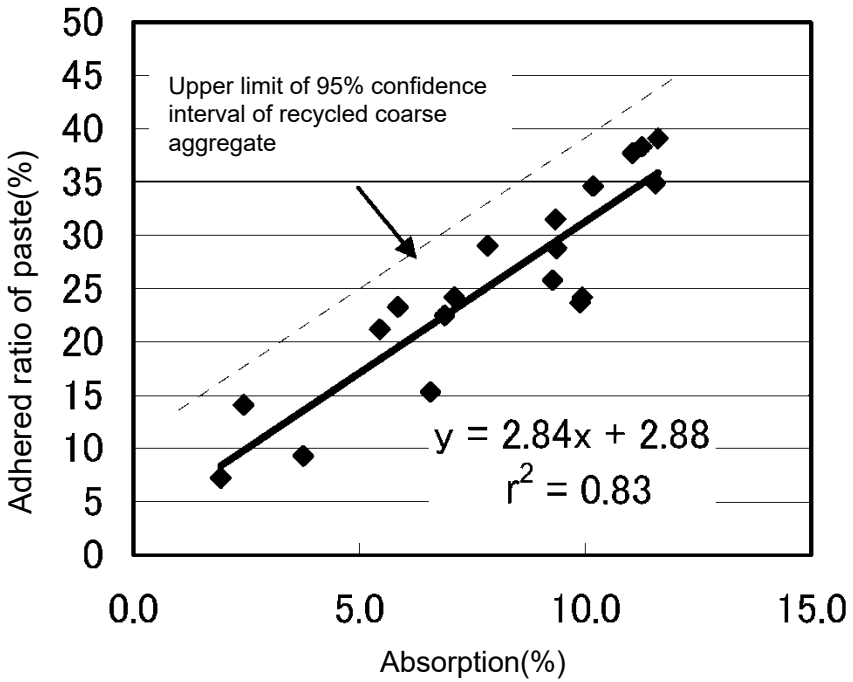
Changes for Annex C (Method for countermeasure restraint alkali-silica reactivity of recycled aggregate concrete M) in this amendment

- The method of countermeasure was considered to accept the mixture use of recycled aggregate L and natural aggregate.
- In former standard total alkali content of recycled aggregate concrete M shall be restricted. In this method the total alkali content is needed to be calculated, however testing by this method is not realistic for time and economic reason.
- Therefore, the total alkali content of recycled aggregate M shall be calculated as to require the relations between absorption of recycled aggregate and cement paste adhered on recycled aggregate, and setting alkali content of adhered cement paste in safety level.

Amendment point of JIS A 5022

Changes for Annex C (Method for countermeasure restraint alkali-silica reactivity of recycled aggregate concrete M) in this amendment





Due to recycled aggregate L is included in basic data, for to create the formula and calculation, the method given in former standard shall be applied for recycled aggregate L without any distinction from recycled aggregate M and recycled aggregate L. However the maximum value of total alkali content of recycled coarse aggregate L shall be specified 0.25% and the maximum value of total alkali content of recycled fine aggregate L shall be specified 0.50%

Amendment point of JIS A 5022

Changes for Annex C (Method for countermeasure restraint alkali-silica reactivity of recycled aggregate concrete M) in this amendment

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

$$Q_{rg} = {}_a Q_{rg} + 1.64\sigma$$

where,

r_{rg}: Total alkali content of recycled coarse aggregate M (%)

Q_{rg}: Absorption of recycled coarse aggregate (%)

${}_aQ_{rg}$: Mean value of absorption for recycled coarse aggregate manufactured before (%)

σ: Standard deviation (%)

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

$$Q_{rs} = {}_a Q_{rs} + 1.64\sigma$$

where,

r_{rs}: Total alkali content of recycled fine aggregate M (%)

Q_{rs}: Absorption of recycled fine aggregate (%)

${}_aQ_{rs}$: Mean value of absorption for recycled fine aggregate manufactured before (%)

σ: Standard deviation (%)

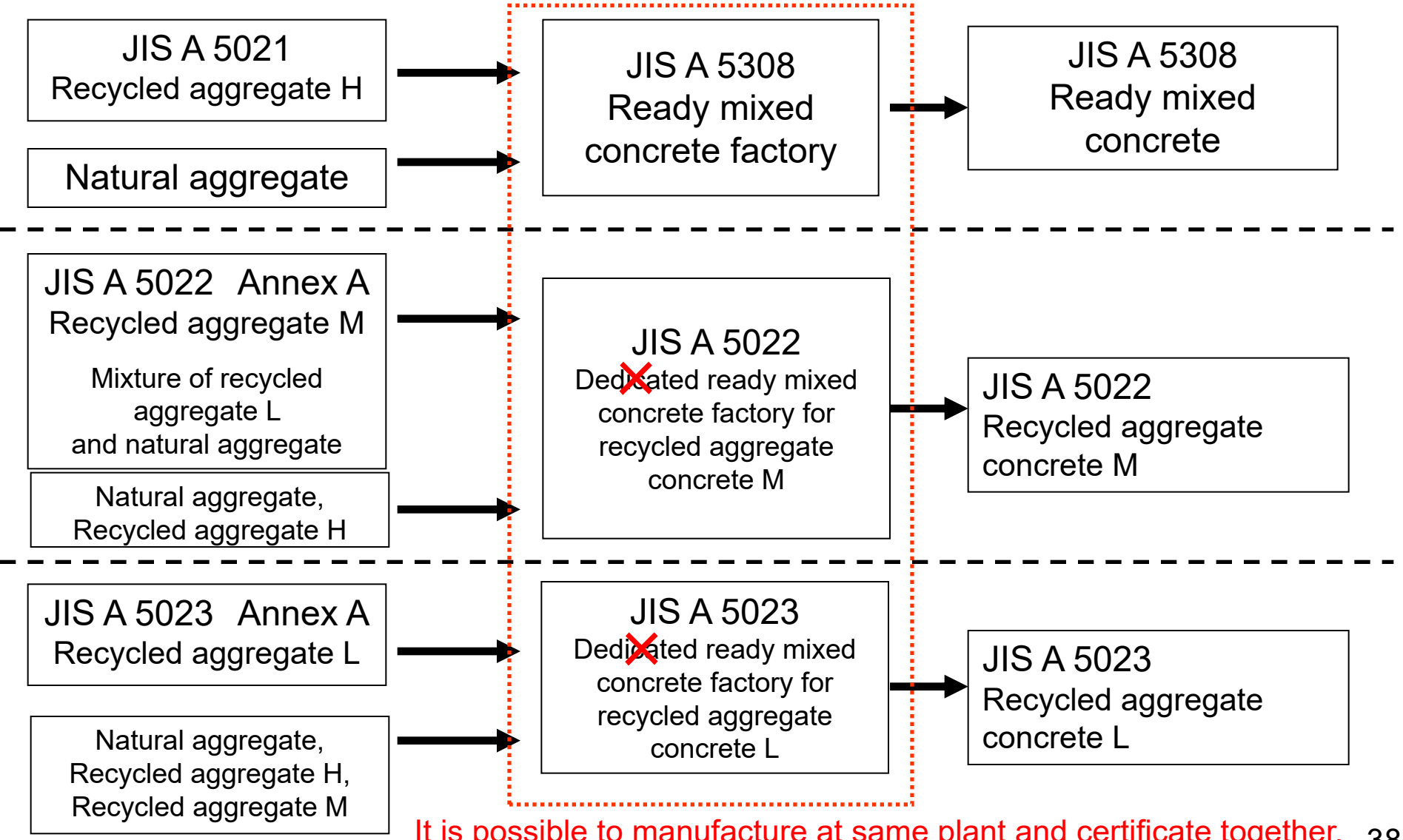
Whole aspect of standard for recycled aggregate concrete

Considering JIS Mark certification for recycled aggregate concrete M

- Discussion has been held that when considering the promotion and establishment of supply system, it is supposed that not only to produce at dedicated plant for recycled aggregate concrete, but also the factory where already manufacture the product certificated by JIS A 5308 may produce the product of JIS A 5022 and JIS A 5023 together.
- As the result, due to the promotion is believed as the first task, it was confirmed that even in the existing JIS A 5308 certificated factory, the recycled aggregate concrete can be manufactured and has no problem for JIS mark certification.
- In this case, at the process of manufacturing (such as mixing), stock or transport the raw material of JIS A 5308, JIS A 5022 or JIS A 5023, the requirement for management method shall be established appropriately to prevent the mixture of concrete or aggregate with manual or the like in company.

Whole aspect of standard for recycled aggregate concrete

Considering JIS Mark certification for recycled aggregate concrete M



It is possible to manufacture at same plant and certificate together.

Thank you for listening.