COE Special Lecture

Environmental factors in concrete materials

Date & time　August 30　13:00～16:00
Place　Hokkaido University I-204 Building

Contents

1 Introduction
2 Mineral concrete materials
3 Chemical admixtures
4 Gas emission
5 Conclusion

Career

School career

Graduate School of Doctor Course of T.I.T. in 1972

Thesis : Hydrolysis reaction of Rare Earth Ions

Job career

02～Present　　Sasanodai Techno Ltd.,

Consultant for construction materials/ Risk Manger

FYI.　01～03　Part time Lecturer of T.I.T.

(Earth Environmental & Energy System)

90～02　　Sika Ltd. R&D Director / Board Member

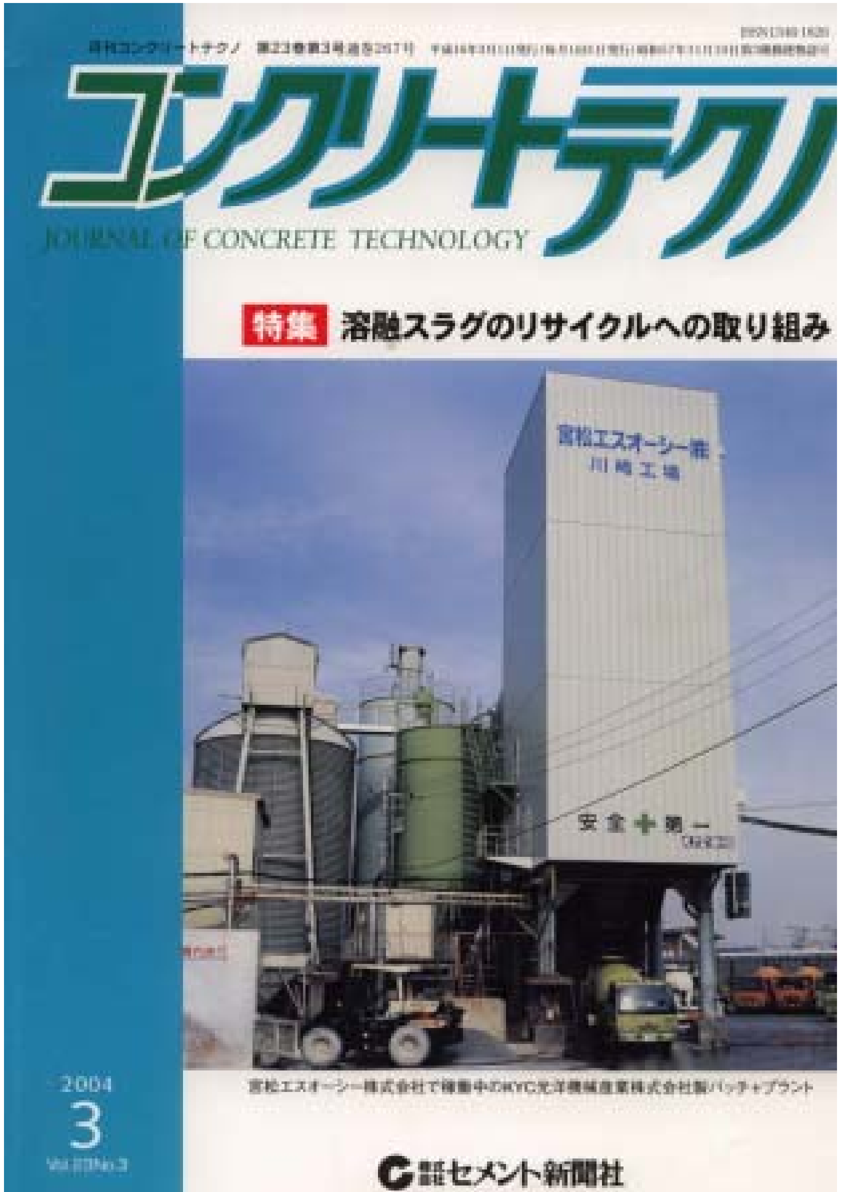
Subsidiary company of Sika FZ, in Zurich

International R&D on construction materials

74～86　　Nihon Cement Ltd.　/　R&D Team Manager

R&D on special cements & fine ceramics

1 Introduction



Editorial Committee since ’92

Obtain information on concrete industry through meeting

Publish serial articles on materials & ecology in concrete since ’99

→ Base of today’s presentation

Presentations & articles on concrete at academic circles mainly focus into :---

Basically important

Raw materials
Workability as RMC
Hardened properties
Structural points
Durability
Fire resistance
etc.

Recently coming

Recycle
Waste
Environment
Ecology
Work accident

Rare case

Gas emission
Safety aspect of materials
Risk Managnt

1) Generally concrete is said to be durable material.

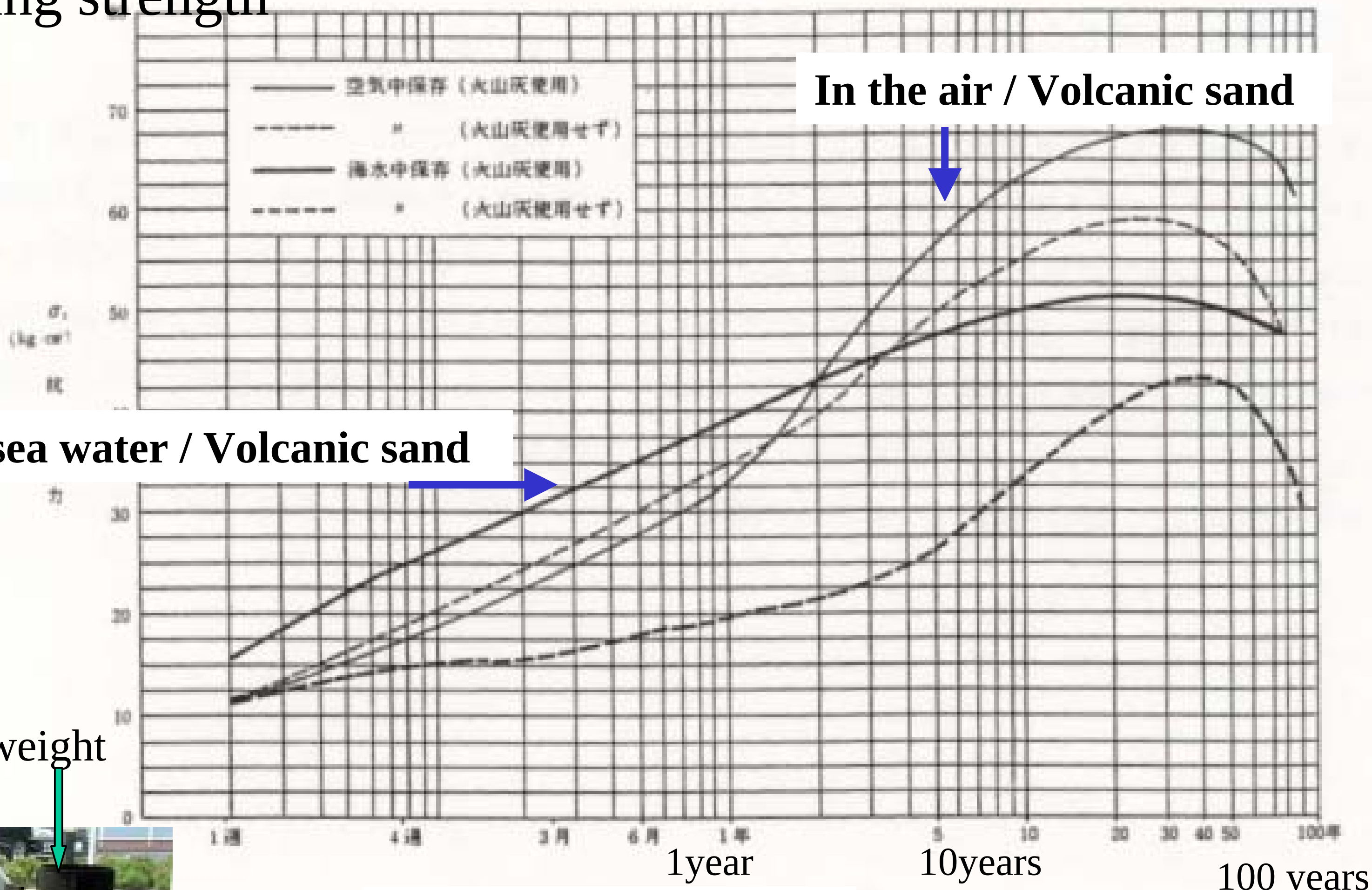
Otaru North Break Water

in 1899

Photo of construction in 1899

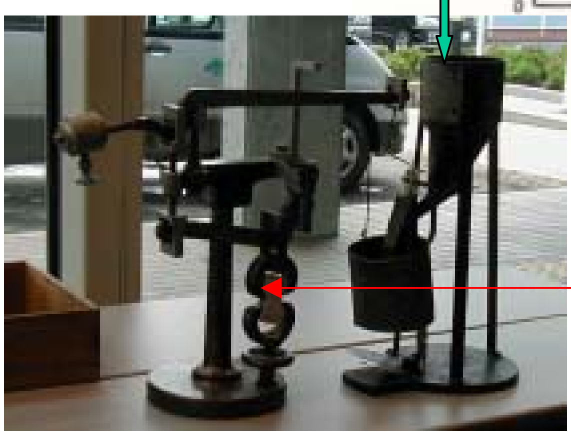
Bigger damage for later constructed part

Pulling strength



Strength of Otaru sample during 100 years

Measure breaking weight



Sample

11th Building of Faculty of Eng. of Univ. of Tokyo

Hammer (Dr.Yoshida)　　Otaru sample (Dr.Hiroi)

10 years smoked sardine by Dr.Yoshida

同右

御前練り供試体

(By Dr.Yoshida & Dr. Kokubu)

If concrete is mixed & filled

with high caution & motivation ⟺ in front of Crown Prince

by hammer checking cautiously ⟺ as Dr.Yoshida did

by dense filling ⟺ as smoked sardine

then **high durable concrete would be obtained**.

2) Complaint caused by own defect & lack of ethics

(1) As the example of own defect near my house

Efflorescence

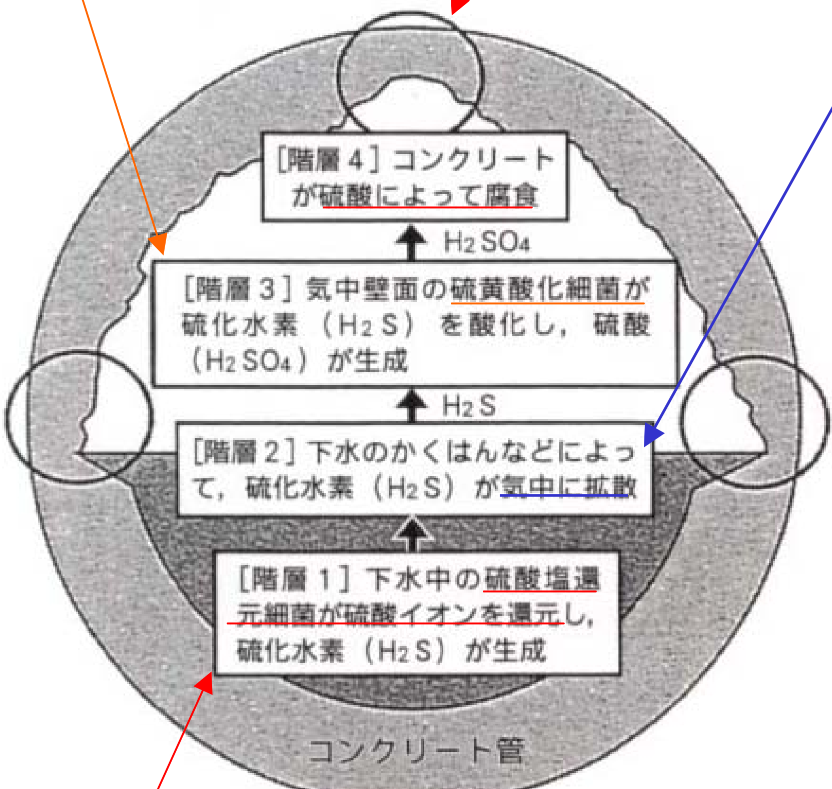
Concrete icicle

(2) Damage of sewerage concrete by bacillus

H_2SO_4 attacks concrete

H_2S changes to H_2SO_4

From liquid to gas phase



SO_4^{--} changes to H_2S

Road sinking at Isarago in Tokyo

（アエラ　02年9月30日号）

(3) Recent topics on concrete in magazine, news paper are


告発スクープ

欠陥コンクリートが

高速道路マンション、学校で……

堂々と使われている!

ビデオカメラがとらえ

衝撃現場!

Defective ready-mixed-concrete by adding water at job-sites
(Ooyamazaki in Kyoto Pref.)

サンデー毎日 03-7-6


鉄筋不足/壁に空洞

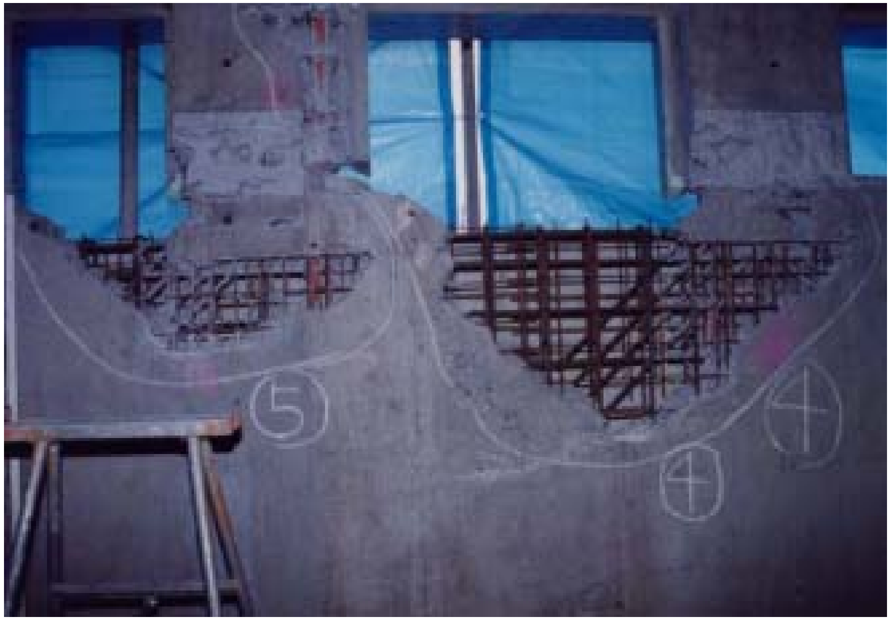
都市公団が欠陥住宅

4社指名停止

総裁にも厳重注意

Defective apartment supplied by Housing & Urban Development Corporation

毎日新聞 03-6-2



Defect of concrete filling

Rock pocket

Those non-acceptable complains came mainly from lack of professional ethics, not from concrete materials itself.

These are main cause of criticism of defective concrete, and before discussing ecological & environmental aspects.

2 Mineral concrete-materials

1) Cement

(1) History

BC7000 Neolithic era in Israel

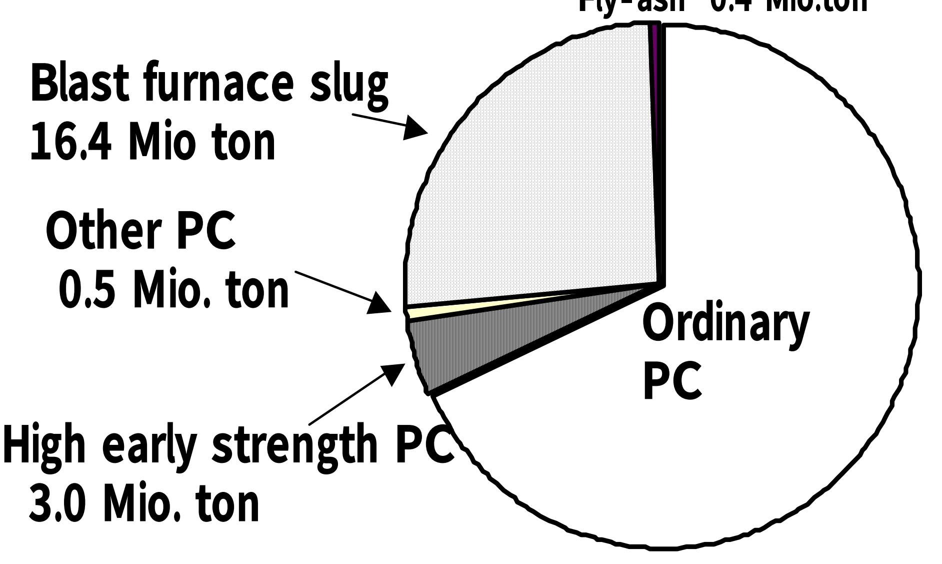
BC3000 In China

BC300 Widely used as construction material in Rome

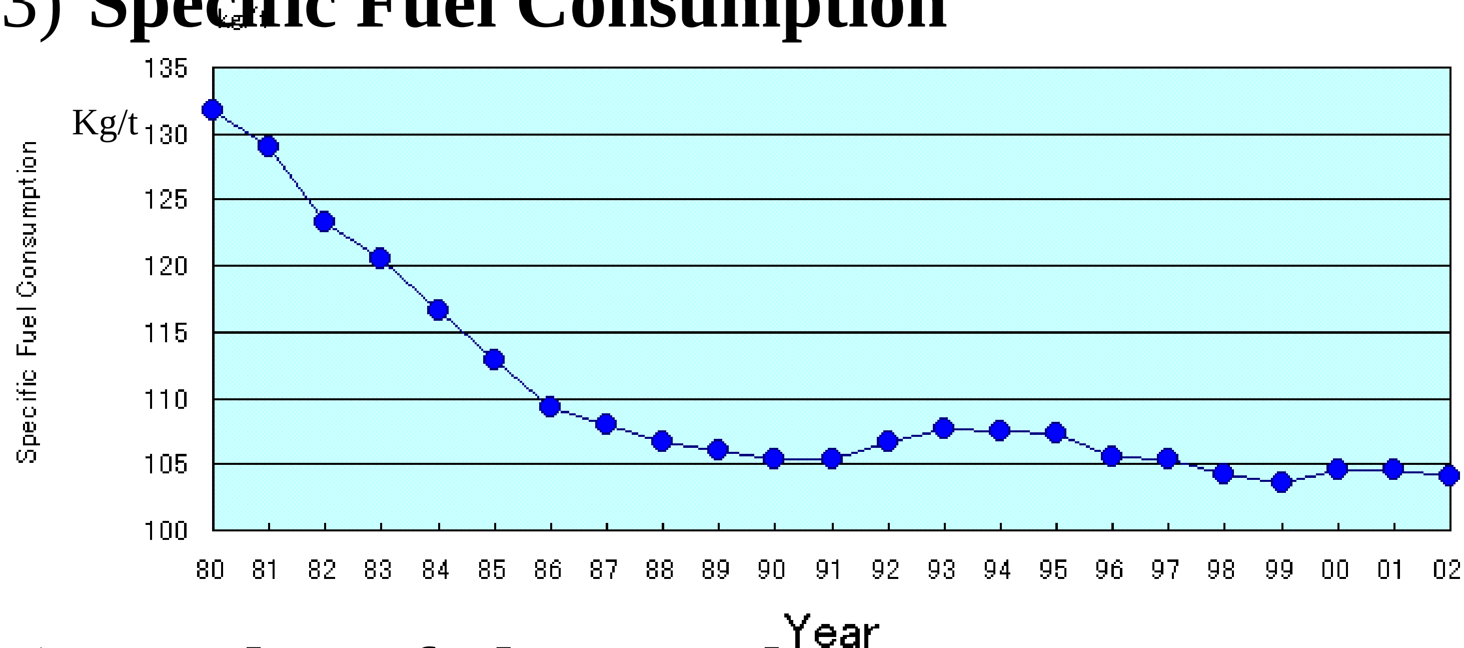
1824 J.Aspdin invented Portland Cement.

(2) Cement production

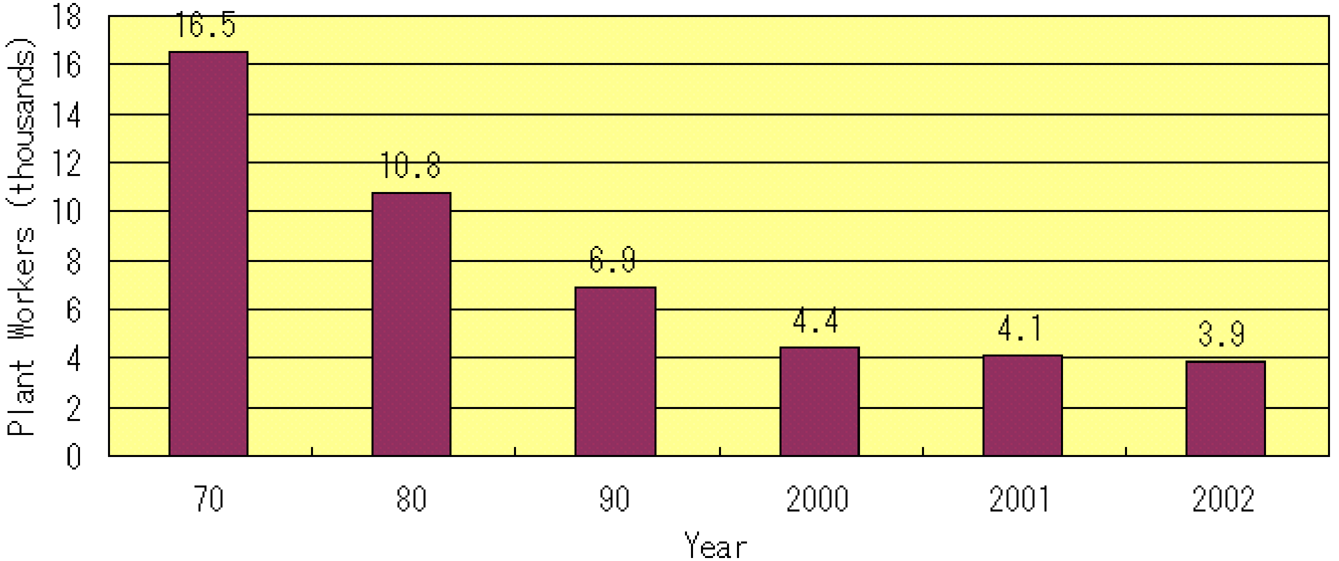
63.8 Mio t in ‘02



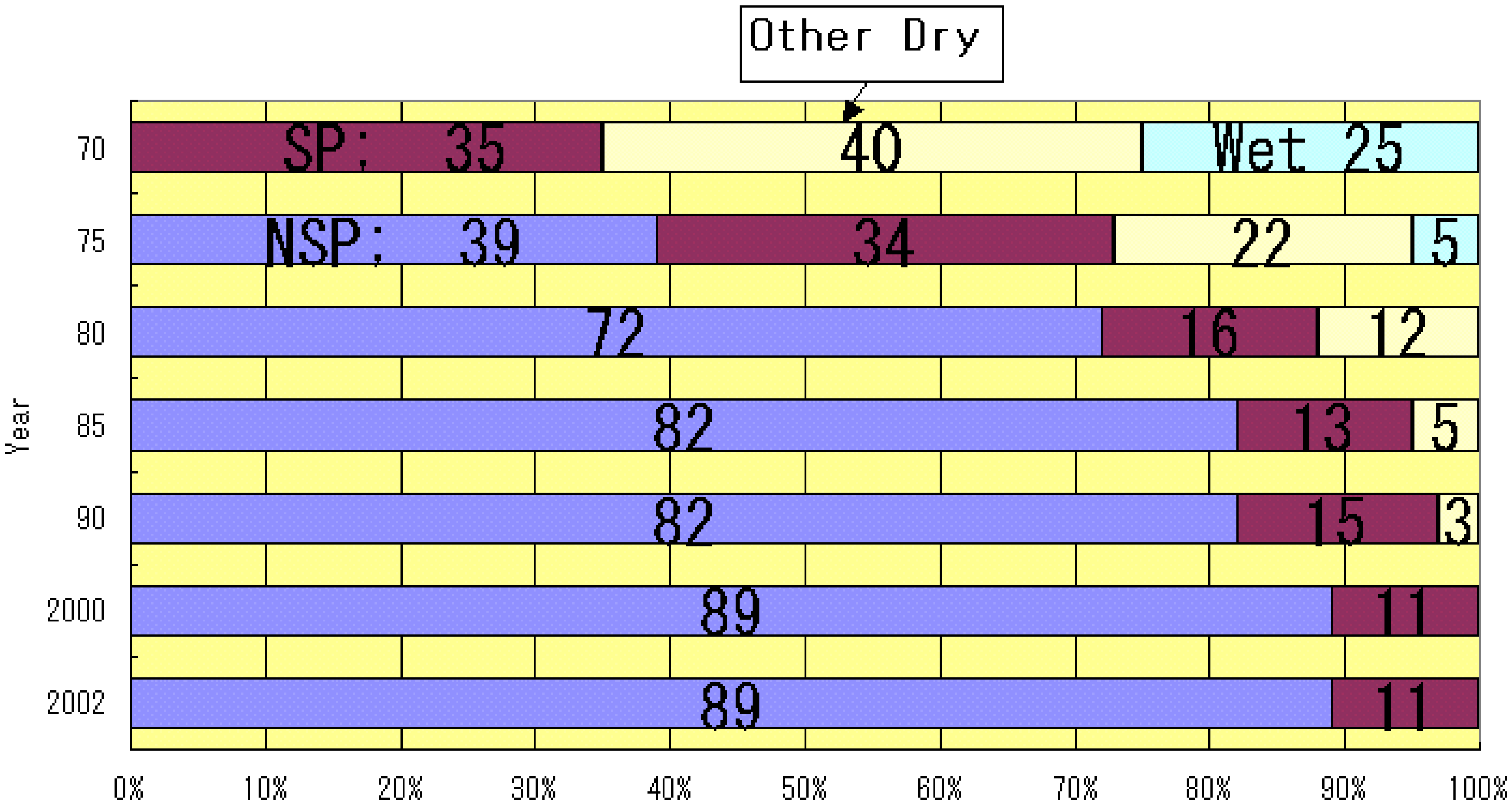
(3) Specific Fuel Consumption



(4) Number of plant workers



(5) Production Ratio by Kiln type



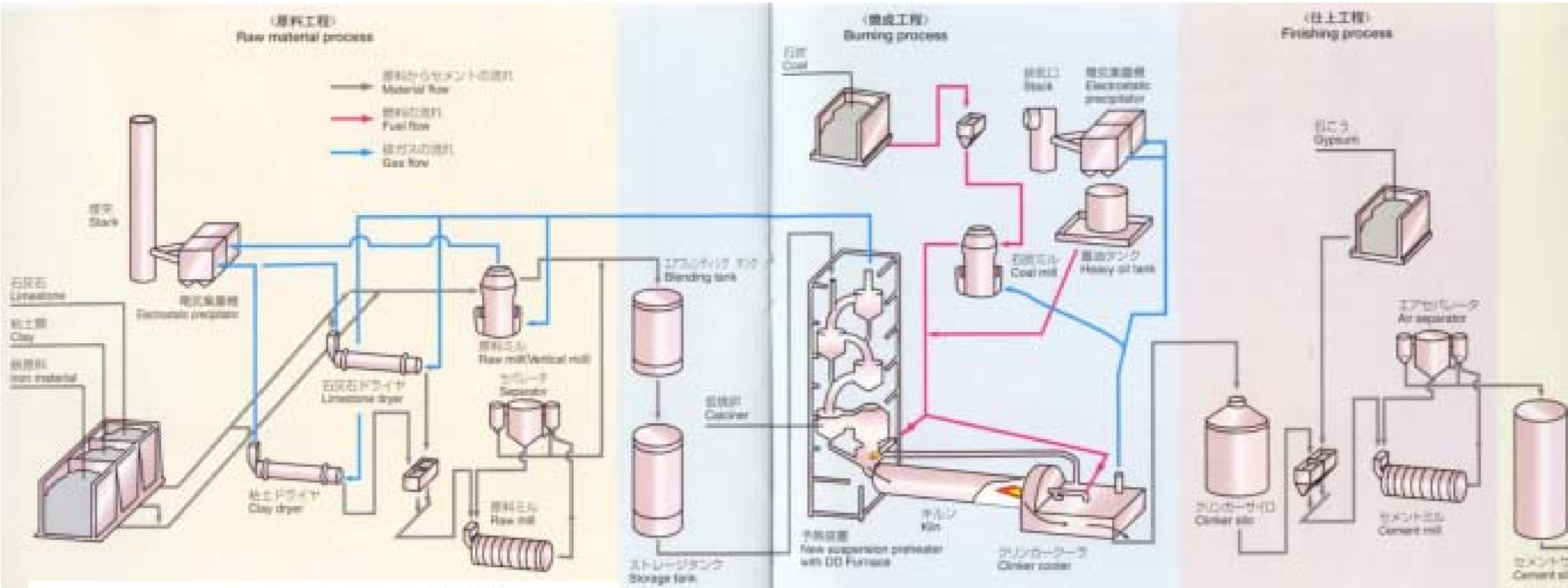
Notes;NSP=Precalciner-type SP kiln SP=Suspension Preheater type kiln

Kumagaya Factory of Taiheiyo Cement Corporation

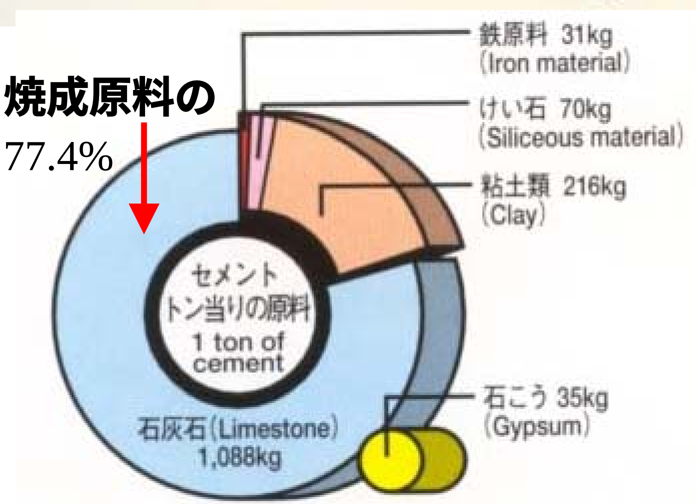
SP	NSP (with calcining furnace)
6 mΦ x 100 mL	5.5 mΦ x 100 mL
170 t/h	322 t/h

(6) Cement production process

Kamiiso Factory of Taiheiyo Cement Corp



焼成原料の
77.4%

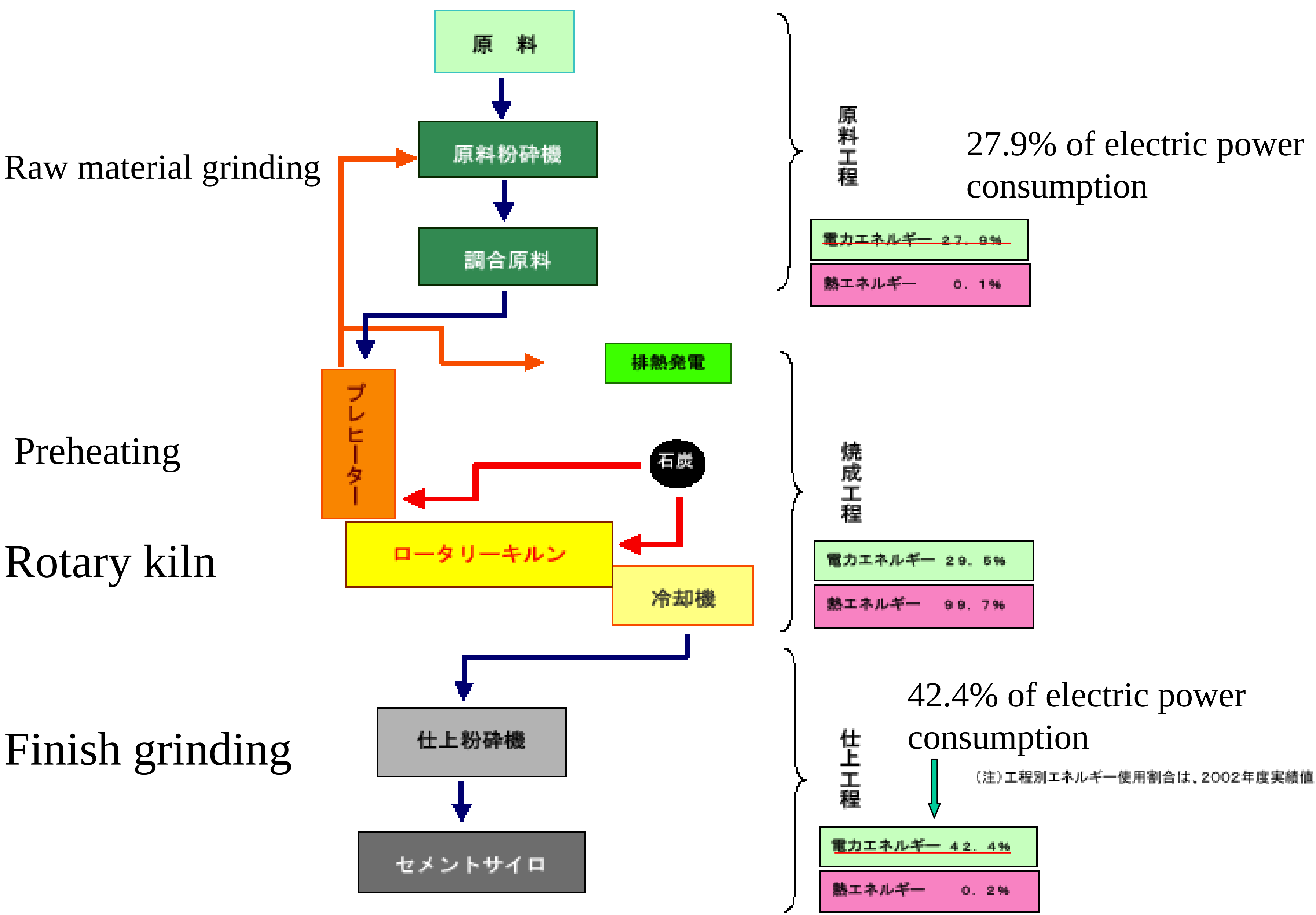


Kiln capacity 177 t/h

Raw mate. → Clinker → Cement

1405kg → 965kg → 1000kg

図－３ ポルトランドセメント製造工程



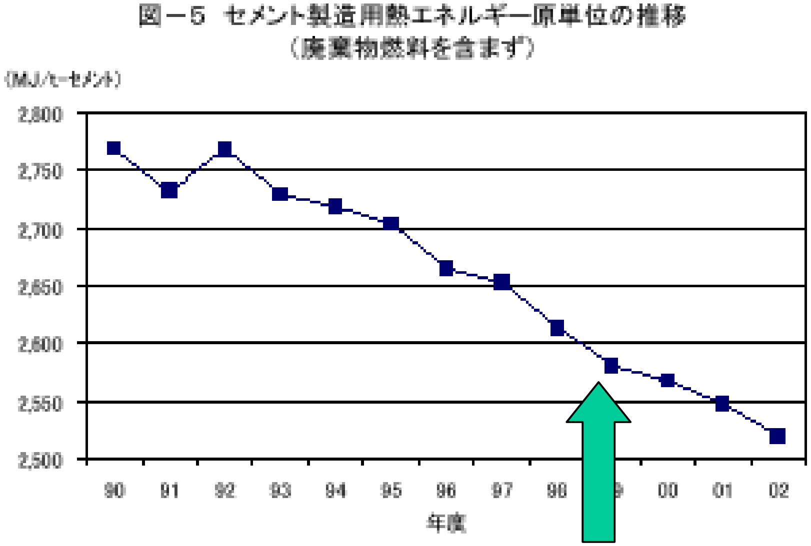
(7) Decrease electric power consumption at griding process is important, but……..

①省エネ設備の普及促進 **の努力**

・粉砕機の竪型ミル化、予備粉砕機設置

・高性能セパレーターの導入

・燃料バーナーの改良



エネルギー消費の70%以上を占めるセメント焼成工程における省エネルギー対策については、既に、1997年度において新鋭設備（NSP・SPキルン）へに転換が100%実施されており、また、排熱利用、熱交換効率の向上等も対応も限界に達しているため、今後の改善余地はほとんど無くなっています。

All kilns are energy effective type, NSP & SP kiln

(8) Cost down using grinding agent, i.e. efficiency

1 **Triethanolamine(TEA)**

Typical grinding agent

TEA is used for many purpose (Annual production ~10,000 t)

2 **Diethyleneglycol**

Irritation to skin, eye…..

Annual consumption in 1996 = 63,300t

30% was used by grinding process in cement industry

3 **Use of grinding agent is know-how for grinding process**

4 **There is possibility of chemical gas emission from cement, which is caused by chemicals added after kiln process.**

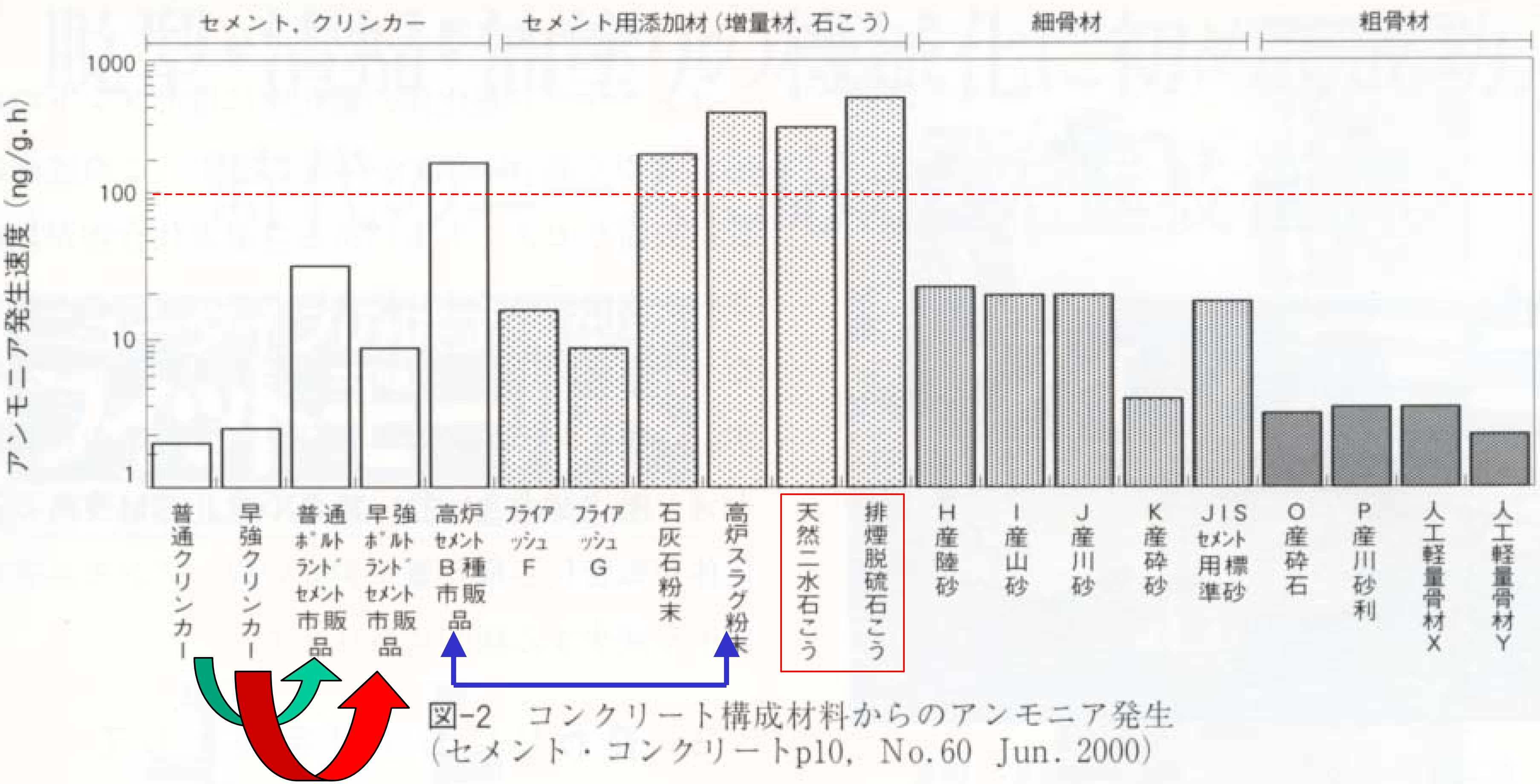
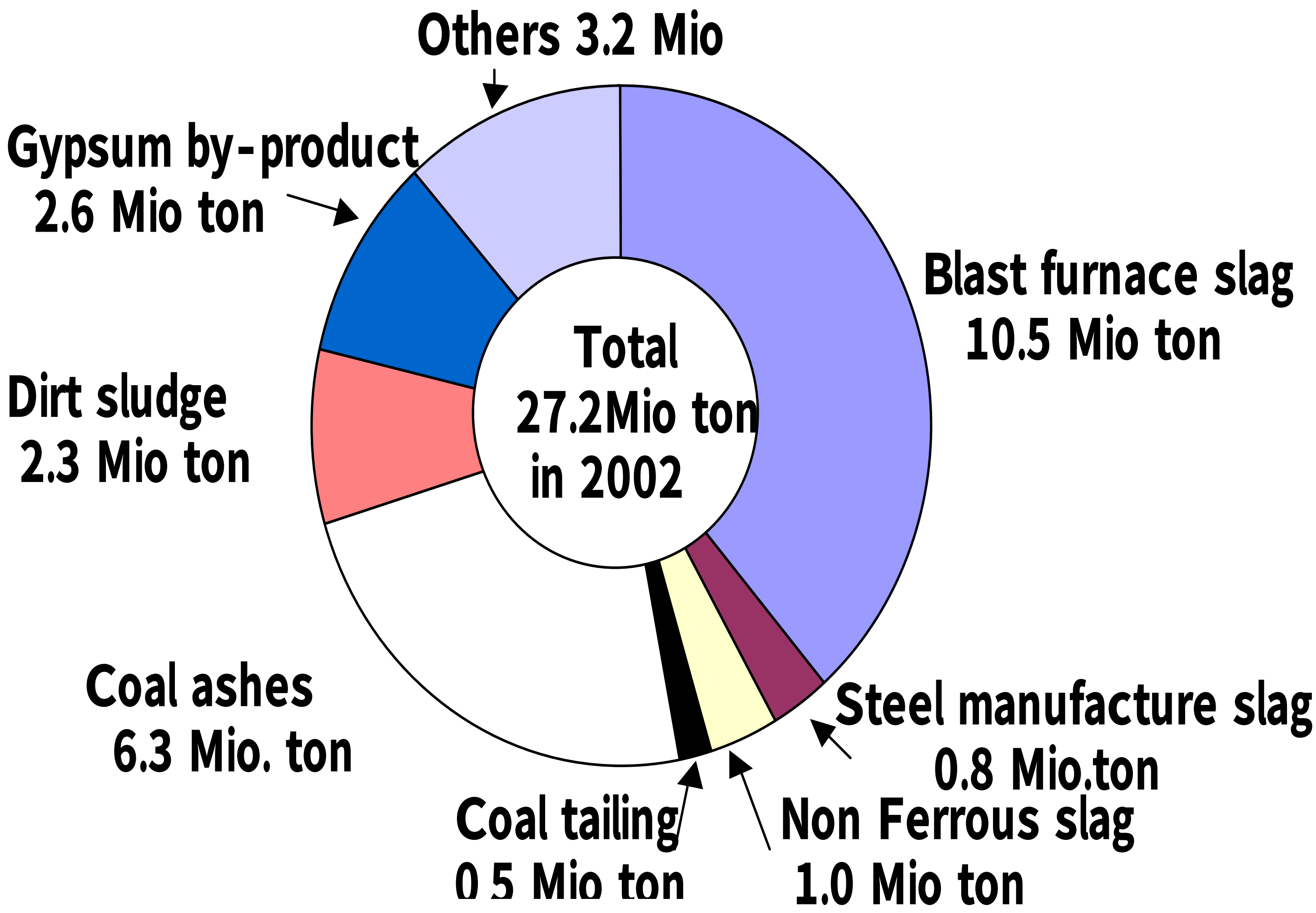


図-2　コンクリート構成材料からのアンモニア発生
（セメント・コンクリートp10，No.60　Jun. 2000）

2) Waste materials used in cement industry



(1) Fly-ash (FA)

① History of use in Japan

After World War, study on fly-ash started mainly by electric power company.

In 1951 Ube Kousan applied FA to quay of Ube Harbor.

In 1953 applied FA to Sudagai Dam.

② Improvement of concrete performance by fly-ash

a Pozzolanic reaction with $Ca(OH)_2$

b Use of FA as mineral admixture

-- Improve workability

-- Decrease heat of hydration

-- Depress alkali-aggregate reaction

-- Depress carbonation speed

Remarks : Pozzolanic reaction

フライアッシュの主成分はSiO_2とAl_2O_3である。ＦＡ自身は水硬性を持たないが、微細粒子の状態で、かつ水分の存在下では、アルカリまたはアルカリ土類と反応して不溶性化合物を生成する。これをポゾラン反応という。ＦＡをセメントと混合した場合、シリカ、アルミナは、セメントの水和によって生成される水酸化カルシウムと徐々に反応し、例えば

$Ca(OH)_2 + [SiO_2、Al_2O_3]$ →

- $3CaO \cdot 2SiO_2 \cdot 3H_2O$ Calcium silicate
- $3CaO \cdot Al_2O_3 \cdot 6H_2O$ Calcium aluminates
- $3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 32H_2O$ Ettringite

③ Mostly generated from coal-fired station

2001	8.8 Mio.t	(30.5 Mio.KW)
2007	10.0 Mio.t	(40.0 Mio.KW)

④ Chemical composition of FA (wt %)

SiO_2	Al_2O_3	CaO	MgO	Fe_2O_3	K_2O	B_2O_3
52.3	26.6	9.4	2.1	5.6	1.1	0.4

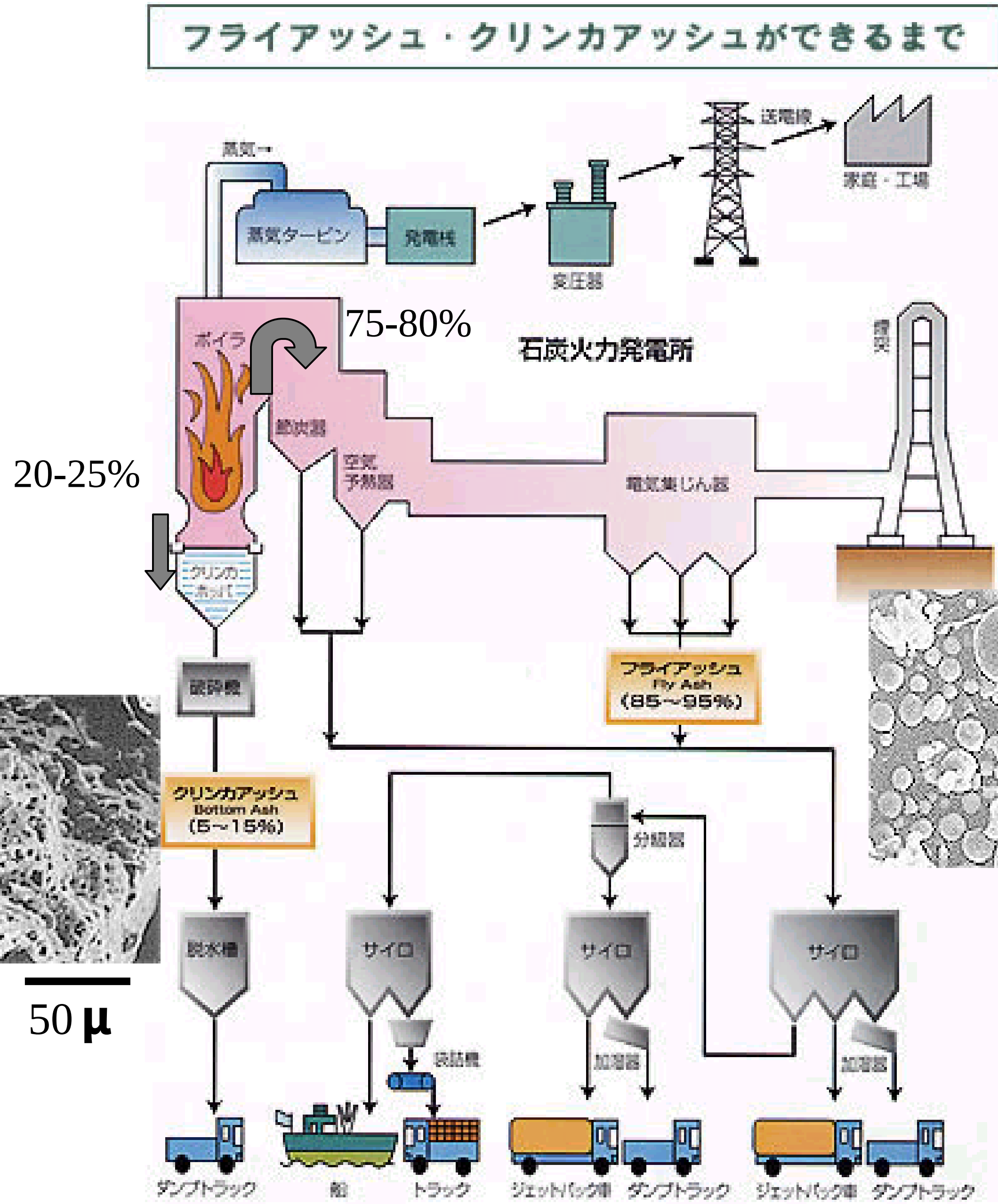
⑤ Quality variation of FA

原料炭の種類・冷却過程や微粉炭の粉砕度合い等により特性が異る
火力発電所間・発生時期の違いにより品質が大きく変動する

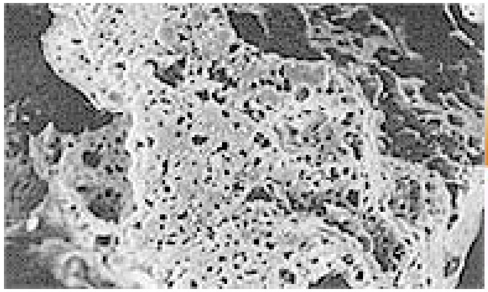
By ignition loss, fineness,etc Ⅰ～Ⅳtype（JIS A 6201）

⑥ Fly-ash & Clinker-ash

燃焼により溶けた石炭灰の粒子は高温の燃焼ガス中に浮遊し、ボイラー出口で温度が低下するため、ガラス状の球形の粒子となり電気集じん器で集められる。

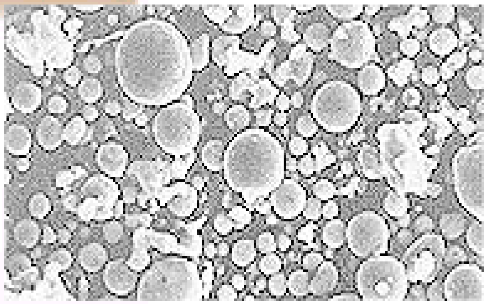


Clinker ash



50 μ

Fly-ash



10 μ

Info.

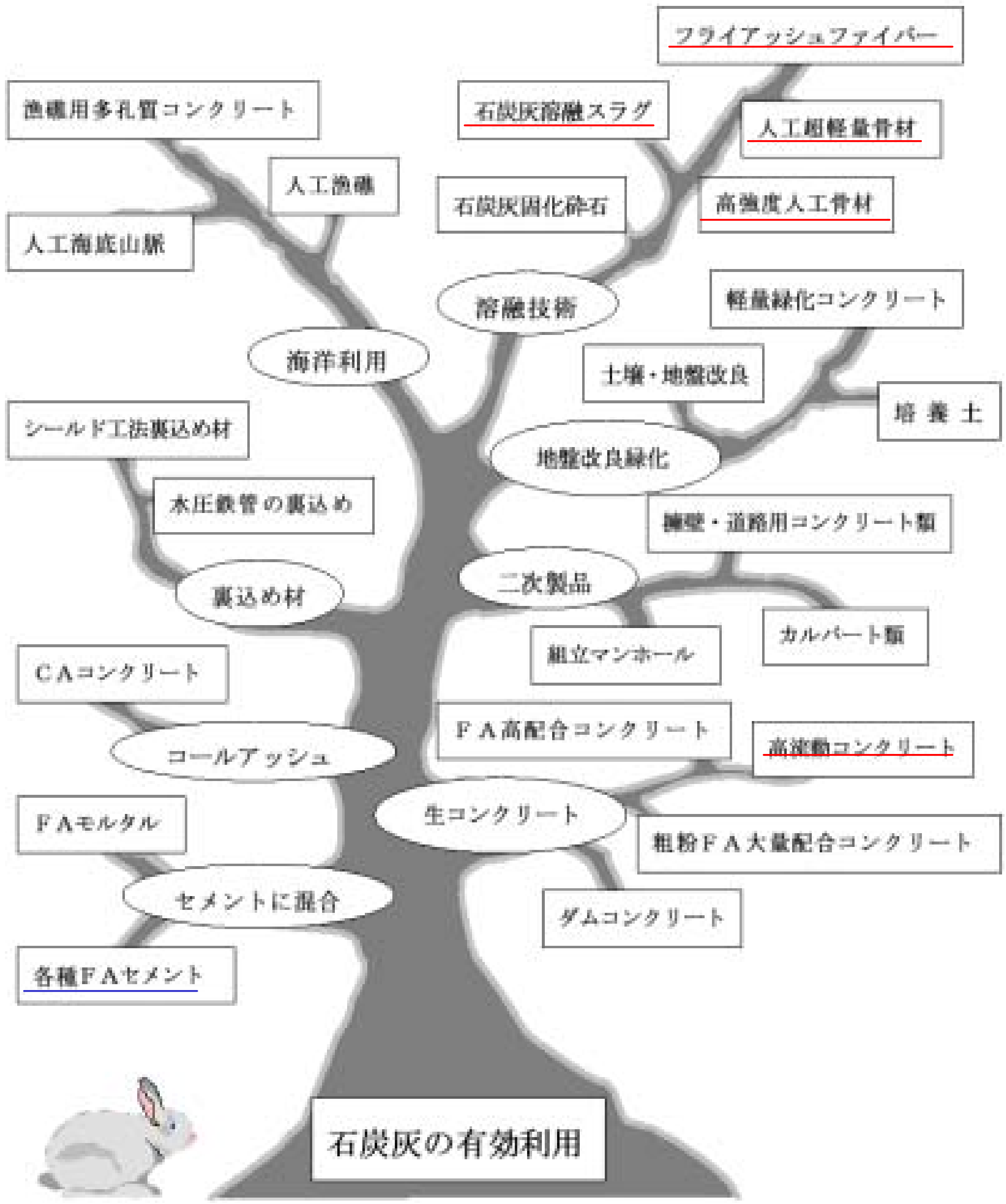
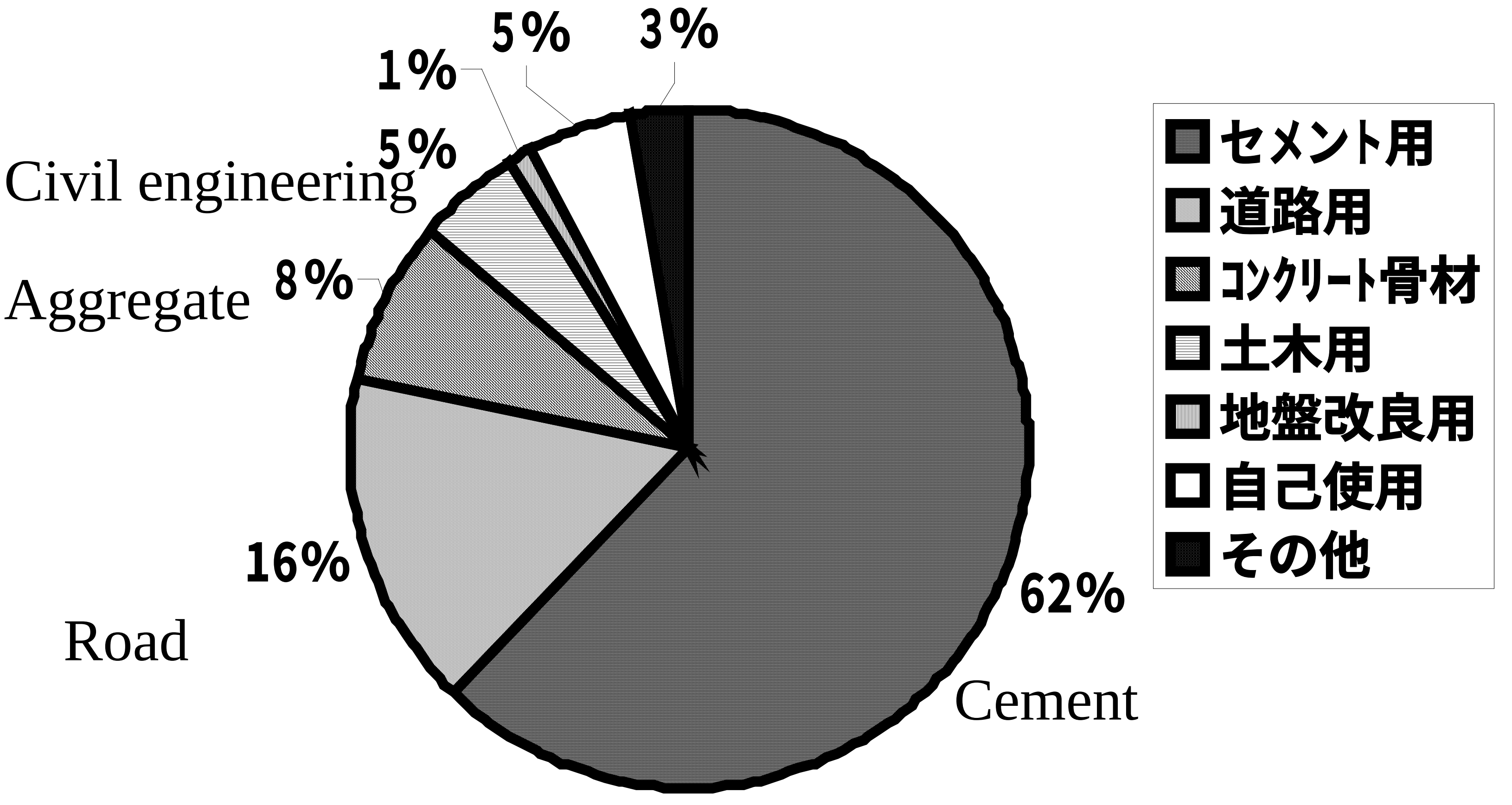


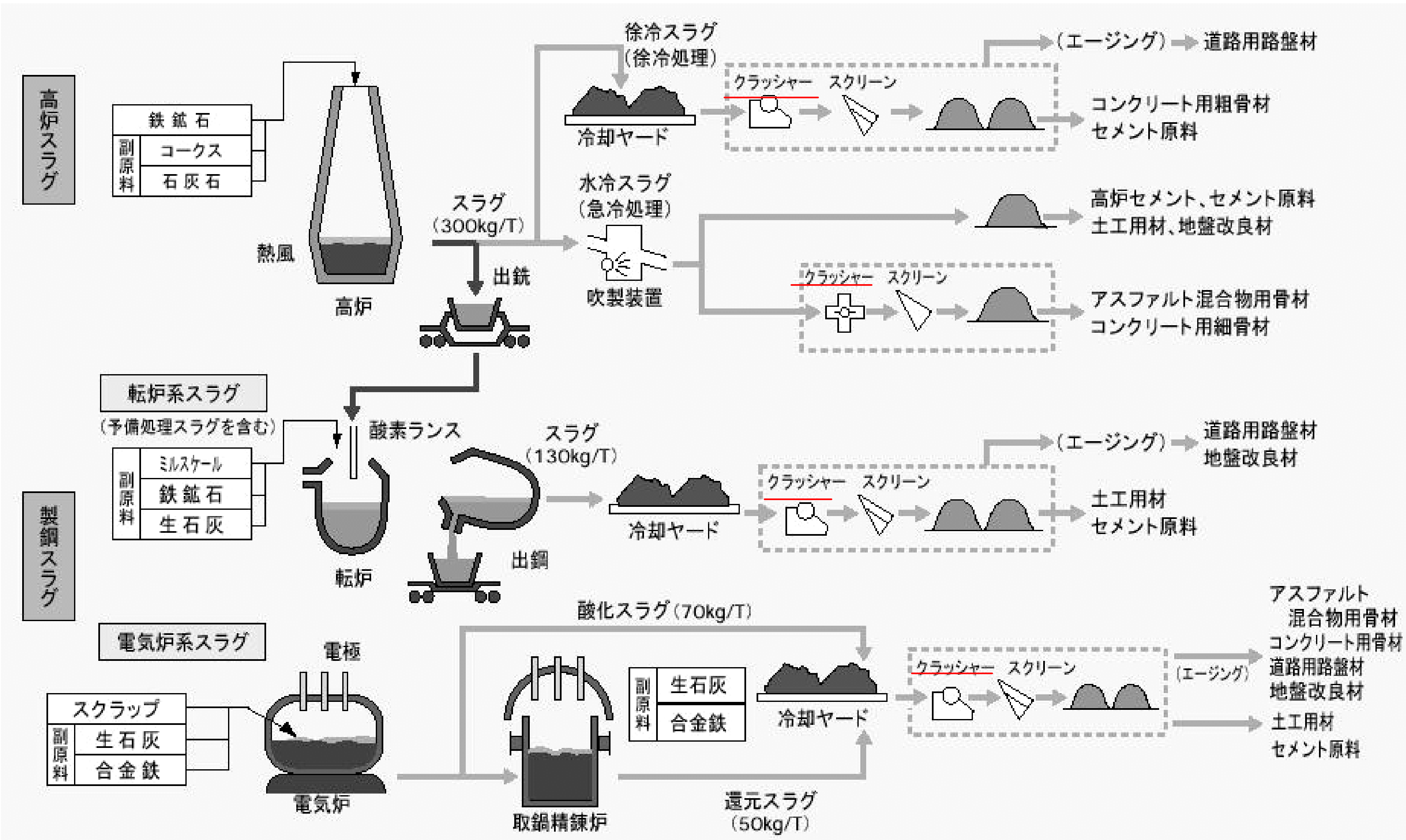
図-3　石炭灰利用の樹木図

(2) Blast furnace slag

① Application Field of blast furnace slag



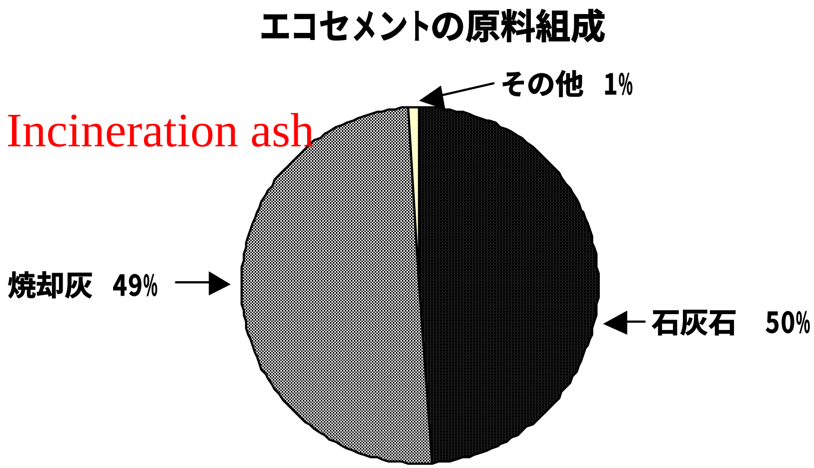
② Production process of slag

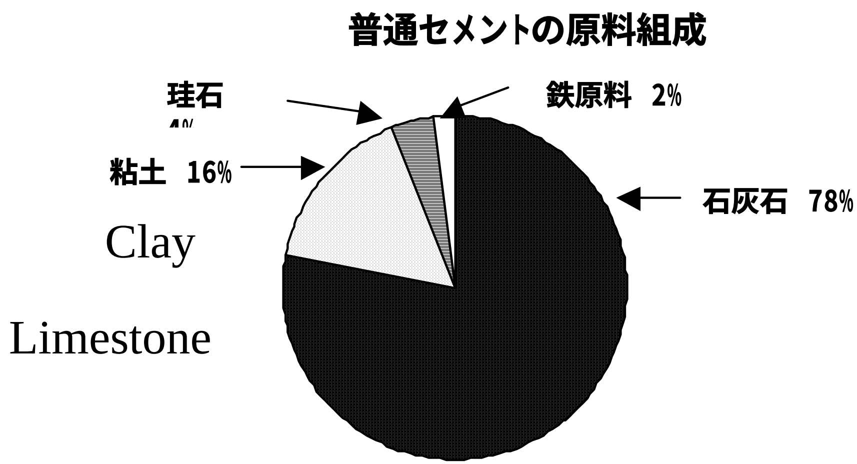


3) Eco Cement

Raw material of Eco cement

Raw material NPC





Composition comparison between Incin. Ash and NPC

	CaO	SiO2	Al2O3	Fe2O3	SO3
Incin. Ash	12 ～ 31	23 ～ 46	13 ～ 29	4 ～7	1 ～ 4
NPC	62 ～65	20 ～ 25	3 ～ 5	3 ～ 4	2 ～ 3

Low content of CaO → Add limestone

High content of Al_2O_3 → Faster hardening type

Cooling for exhaust gas for :--

-- avoiding dioxin re-generation

-- recovery of heavy metal

Capacity : 315 t/day