

2012  
Report on Questionnaire Survey  
on Research and Development  
in the Construction Industry

March 27, 2013

Technical Subcommittee on Research and  
Development Management  
Technical Research Subcommittee  
Research & Development Committee  
Japan Federation of Construction Contractors



## Foreword

Japanese general contractors, including members of the Japan Federation of Construction Contractors, have their own design division, have advanced technology and conduct technical R&D by themselves. These features are only unique to the construction industry in Japan, rarely seen in the rest of the world.

The Research & Development Committee believed it effective in improving the impression of the construction industry to make R&D activities of the construction industry widely known to the Japanese people to help them take an interest in the industry. Based on this idea, we decided to investigate the status of R&D in the construction industry, and the Special Subcommittee on Research and Development Management took on this survey task in 2012.

This report is a summary of the results of the questionnaire survey conducted to 55 member companies of committees under the Building Division from the end of September to the middle of October. The questionnaire asked a variety of questions about R&D activities of the respondents' companies, ranging from the corporate profile, basic matters on R&D, personnel, organization, budget, and R&D theme. It is our pleasure if this report helped as many people as possible understand some of the R&D activities of the construction industry.

March 27, 2013  
Chairman Yoshiyuki Norihisa  
Research & Development Committee  
Japan Federation of Construction Contractors

Members related to preparation of the Questionnaire Survey Report  
on R&D in the Construction Industry

Companies listed by the Japanese syllabary order and  
personal names shown without honorifics

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# Questionnaire Survey Report on R&D in the Construction Industry

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## 1. Introduction

The 2012 Project Master Plan of the Japan Federation of Construction Contractors state in one of the priority action programs, ⑥ Promotion of Technical Development and its Utilization, as follows:

### ⑥ Promotion of Technical Development and its Utilization

It is a basic mission for the construction industry to meet the diversifying and advanced needs with high quality products and services. To accurately accomplish the goals, every company in the industry makes an effort to constantly develop new technologies and improve existing technologies. JFCC provides support to those Japanese construction companies and endeavors to establish the appropriate environment for promotion of the industry's utilization of technology by taking various actions, including making official requests or proposals on legal systems and writing and diffusing technical standards and guidelines.

Keenly aware of the position of R&D seen as one of the priorities as described above and considering the new organization born out of merger of relevant organizations for the purpose of reinforcement and efficiency improvement of construction business, the Special Subcommittee on R&D Management decided in 2012, one year after the establishment of JFCC, to make more externally open the survey conducted for years mainly to Special Subcommittee member companies and modified the survey so that it is designed to disclose information more actively to the general public. The new survey started this year. The outcome of the survey results is summarized here for public disclosure.

## 2. Survey Overview

### 1) Subject companies of the survey

- The questionnaire was sent to 55 companies who are members of committees under the Building Division of JFCC, and the answers were returned from 40 companies.

### 2) Survey period

- The survey was sent on September 27, 2012, and the answered received by the deadline, October 20, were accepted.

### 3) Survey method

- The contact person of each company was informed of the questionnaire survey, and the questionnaire was sent to the R&D sections of each company through the contact person.

### 4) Subject survey period

- The subject point in time for the survey is March 31, 2012. On financial matters, the period of one year back from March 31, 2012, or any immediate point in time, is the subject survey period.

### 3. Survey Description

#### 1) The purport of the questionnaire and the answering procedure

September 27, 2012

To Whom It May Concern

Research & Development Committee, Building Division,  
Japan Federation of Construction Contractors

#### **Request on the Questionnaire Survey on R&D Activity in the Construction Industry**

The Research & Development Committee, the Building Division of the JFCC decided to conduct the above questionnaire survey. We would like you to understand the purport of this survey, fill in the form and return it to us.

Established from merging of three organizations in April last year, JFCC practically started its activity simultaneously with the occurrence of the Great East Japan Earthquake. The launch of the organization faced huge challenges of restoration and rehabilitation of disaster victims and afflicted areas.

The construction industry provides buildings and structures to ensure a safe and secure environment in people's living and industrial activities and establish sustainable and vital economic society and, when a natural disaster occurred, plays an important role in restoration and rehabilitation at afflicted areas. It is necessary to make those roles of the construction industry that serves as one of the basic foundation-supporting industries of Japan widely known to the general public. In this respect, "promotion of society's understanding of the construction industry" is cited as one of the priority action programs of JFCC.

The survey aims to obtain the basic data necessary to put up the construction industry's proposals or formulate the industry's plans by clarifying the status of R&D activities in the construction industry, such as how each company conducts R&D with how much budget and how many staff and on what themes, and to make the R&D activities of the construction industry widely known to the general public by disclosing the results to society, thereby ultimately improving the impression of the construction industry. To this end, we are going to conduct the Questionnaire Survey on R&D Activity in the Construction Industry.

#### Answering Procedure

##### 1. Survey Subjects

- Considering the need to avoid extra burden on member companies, the companies participating in the committees of the Building Division are requested to respond to the questionnaire.

##### 2. Entry Procedure

- Directly enter the answer in the cell .
- Select the appropriate answer from the pull-down menu for the cell .
- Enter the data as of March 31, 2012.
- For the answers on financial matters, enter your information for one year back from March 31, 2012, or any given date near it.

##### 3. Deadline

- **Please return the questionnaire to us by October 20, 2012.**
- Send your questionnaire responses to the address of the contact person shown at the end of this form via e-mail.

##### Note

This survey is conducted by the Technical Subcommittee of Research and Development Management and the staff of the Secretariat. The information given by the respondents and this survey will be handled according to the following rules:

##### [Survey Procedure]

##### 4. Handling of Answers

- We will handle the information given by the respondents with respect to this questionnaire as strictly classified information.
- The staff of the Secretariat shall be responsible for summation of the answers given by the respondents.
- The Technical Subcommittee of Research and Development Management shall be responsible for preparation of reports using the summation results.
- The information given by the respondents shall solely be used for the intended survey.

##### 5. Handling of the Survey Results

- The questionnaire survey results will be disclosed on the website of JFCC.
- Care shall be taken to make no company names identifiable in any way in the survey results.

Contact person on this survey:

Ryousuke Takuwa, Building Division, Japan Federation of Construction Contractors (takuwa@nikkenren.or.jp).  
8F, Tokyo Kensetsu Kaikan, Hacchobori 2-5-1, Chuo-ku, Tokyo 104-0032  
TEL 03-3551-1118 FAX 03-3555-2463

2) Contents of the questionnaire

**[Questionnaire Sheet]**

Company:  Filled in by:  Title:   
 Phone:   
 E-mail:

**A. Basic Corporate Information**

- 1) No. of employees
- 2) Sales volume  ¥ million
- 3) Implementation of R&D 
  - a) Conduct R&D in-house
  - b) Conduct no R&D in-house, but subcontract or commission R&D to an external contractor
  - c) Conduct no R&D \*

**\* When c) is chosen, it is the end of the questionnaire. Thank you for your cooperation.**

**B. Organizational System for R&D**

- 1) Dedicated division for planning/management of R&D
- 2) Dedicated R&D division with their own experiment facility
- 3) Dedicated R&D division without their own experiment facility
- 4) Division responsible for intellectual property management
- 5) No. of researchers \*

\* Researchers include not only those dedicated to research in laboratories or research divisions but also those who spend the majority of their service time on R&D.

This definition is almost the same as that of "those mainly engaged in research" used in the questionnaire of the Ministry of Internal Affairs and Communications or that of "the number of researchers" used in Nikkei Questionnaire.

**C. R&D Expense**

- 1) Expense incurred for the entire company (expense publicly announced)
- 2) Ratio of 1) to the sales volume
- 3) Ratio of 1) to the previous year's cost  %
- 4) Percentages of fundamental research, applied research and development
  - Make sure the total values becomes 100%.
    - a) Fundamental research  %
    - b) Applied research
    - c) Development
- 5) Ratio of short-term themes (less than 2 years) and medium- and long-term themes
  - Make sure the total values becomes 100%.
    - a) Short-term  %
    - b) Medium- and long-term  %
- 6) Percentages of the expenses on building themes, civil engineering themes and joint themes
  - Make sure the total values becomes 100%.
    - a) Building  %
    - b) Civil engineering
    - c) Joint

**D. R&D Themes**

- 1) Total number of R&D themes
- 2) Percentage of R&D themes on each field
  - Make sure the total values becomes 100%.
    - a) Global environment  %
    - b) Safety and security  %
    - c) Quality and productivity improvement  %
    - d) Comfort and health  %
    - e) Others  %

3) Percentage of R&D theme expense on each field

- Make sure the total values becomes 100%.

- a) Global environment
- b) Safety and security
- c) Quality and productivity improvement
- d) Comfort and health
- e) Others

	%
	%
	%
	%
	%

4) Fields with particular interest

- Select from the following table. (up to five)
- When "Others" is selected in each item, write the specific name in the table.


	Major category	Sub category	
a-1	Global environment	Energy saving or CO2 reduction (including energy management such as BEMS or smart grid)	
a-2		New energies (solar power, wind power, biomass, etc.)	
a-3		Ecosystem preservation (biodiversity, etc.)	
a-4		Greening and prevention of the heat island effect	
a-5		Soil remediation and water purification	
a-6		Waste disposal/treatment and recycling	
a-7		Others	
b-1	Safety and security	Anti-earthquake measures (aboveground: earthquake resistance, vibration control, base isolation)	
b-2		Anti-earthquake measures (underground: pile, foundation, ground, seismic motion)	
b-3		Anti-earthquake measures (nonstructural members: ceiling, curtain wall, etc.)	
b-4		Anti-earthquake measures (others)	
b-5		Anti-tsunami measures	
b-6		Measures against meteorological disasters (typhoon, flood, lightning, sediment disaster, etc.)	
b-7		Anti-wind measures	
b-8		Fire prevention	
b-9		Security	
b-10		BCP or risk assessment	
b-11		Structural analysis	
b-12		Others	
c-1	Quality improvement and productivity improvement	Concrete	
c-2		Finishing materials	
c-3		Other materials	
c-4		Aboveground structural method	
c-5		Underground structural method	
c-6		Execution management (IT-based execution, etc.)	
c-7		Robot or automated construction	
c-8		Ground, bedrock, foundation	
c-9		Maintenance	
c-10		Others	
d-1	Comfort and health	Noise and vibration environment	
d-2		Temperature, humidity, or light environment	
d-3		Air environment	
d-4		Electromagnetic wave or radiation	
d-5		Others	
e-1	Others	Theory of design and planning (building inside, urban planning, etc.)	
e-2		BIUM-related technology	
e-3		Engineering technology (technology related to production facility, medical facility, research facility)	
e-4		Others	

5) R&D theme to restoration from earthquake disasters

6) No. of releases issued by the field in the past one year  
• This "release" includes information disclosed on the official website as "news releases" or information announced as press releases.

- a) Global environment
- b) Safety and security
- c) Quality and productivity improvement
- d) Comfort and health
- e) Others

7) Major R&D results in the past one year  
• Enter the name of each specific technology by the field.

a) Global environment

b) Safety and security

c) Quality and productivity improvement

d) Comfort and health

e) Others

8) Cooperation with universities or companies such as joint research or contract research

9) If your answer is yes for 8), describe the type of cooperation.  
a) Joint research

b) Contract research

c) Others \* Describe in detail (at your option).

4. Questionnaire Results and Analysis

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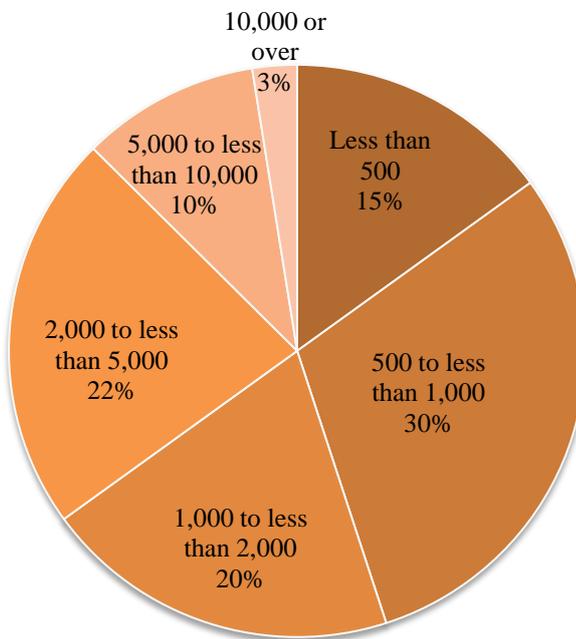
A. Basic Corporate Information

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A-1) No. of employees

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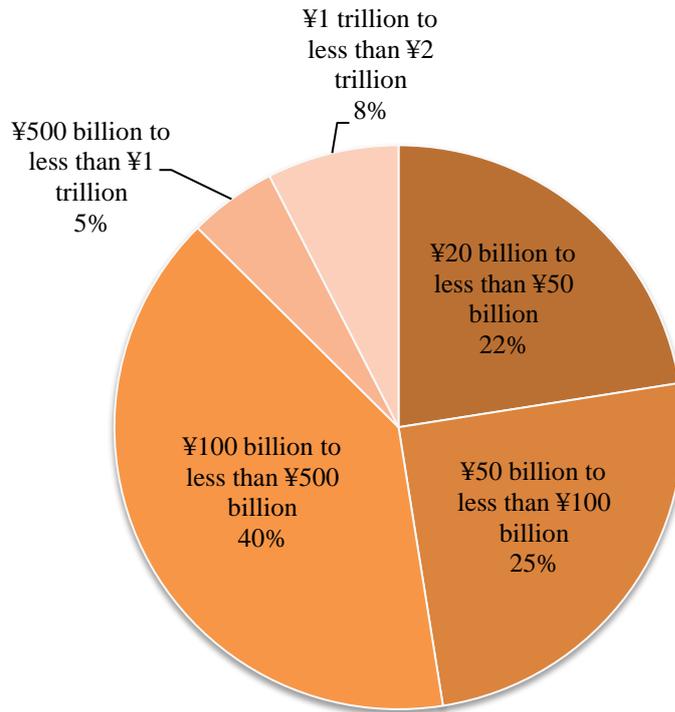
No. of employees

(No. of respondents: 40)

- 
- The numbers of employees provided by all forty respondent companies are graphically classified by the scale.
  - 30% (12 companies) are categorized into a range from 500 to less than 1,000, the largest bracket, followed by 22% (9) from 2,000 to less than 5,000 and 15% (6) with less than 500.
-

A-2) Sales volume

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Sales volume

(No. of respondents: 40)

- 
- Sales volumes provided by all forty respondent companies are graphically classified by the scale.
  - 22% (9 companies) are ranged in a sales volume from ¥20 billion to less than 50 billion, 25% (10) in the range from ¥50 billion to less than 100 billion, 40% (16) from ¥100 billion to less than 500 billion, 5% (2) from ¥500 billion to less than ¥1 trillion, and 8% (3) from ¥1 trillion to less than ¥2 trillion.
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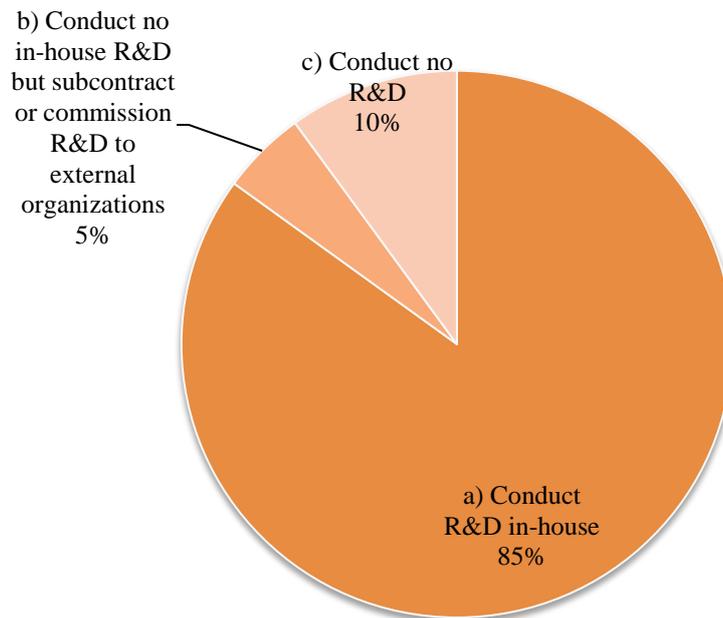
## A. Basic Corporate Information

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### A-3) Implementation of R&D

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Implementation of R&D

(No. of respondents: 40)

- 
- The status of R&D activity for 40 respondent companies is graphically presented.
  - In-house R&D is chosen by 85% (34 companies). No in-house R&D but R&D commissioned or subcontracted chosen by 5% (2). 10% (4) conduct no R&D in any manner.
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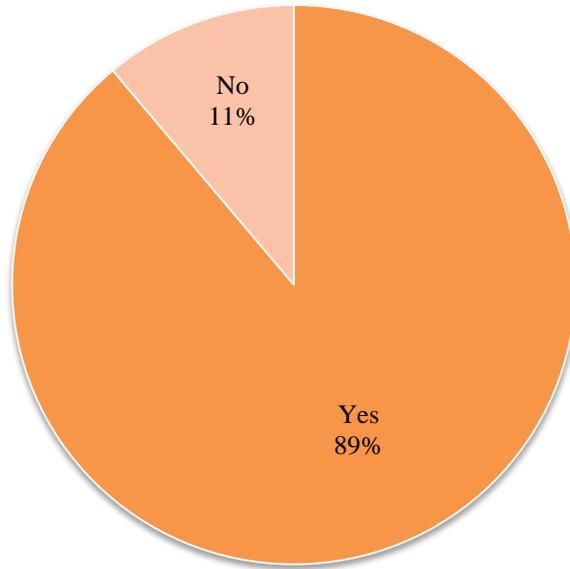
B. Organizational System for R&D

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B-1) Dedicated division for planning/management of R&D

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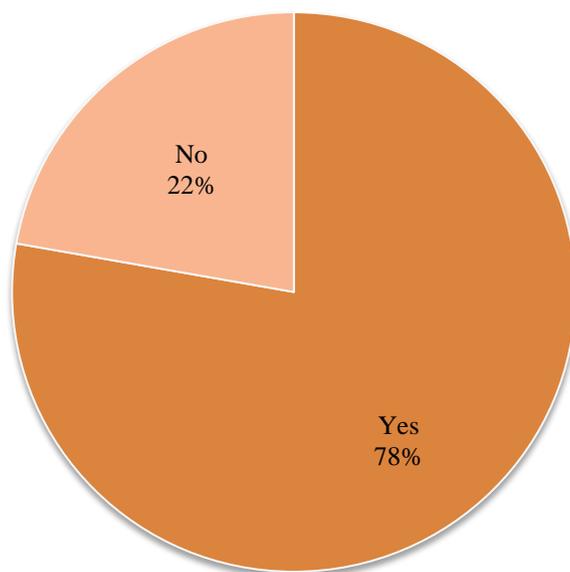


Dedicated division for planning/management of R&D

(No. of respondents: 36)

- 
- 89% or 32 companies out of 36 respondents who answered they conduct R&D said they have a dedicated division for planning and management of R&D.
-

B-2) Dedicated R&D division with their own experiment facility

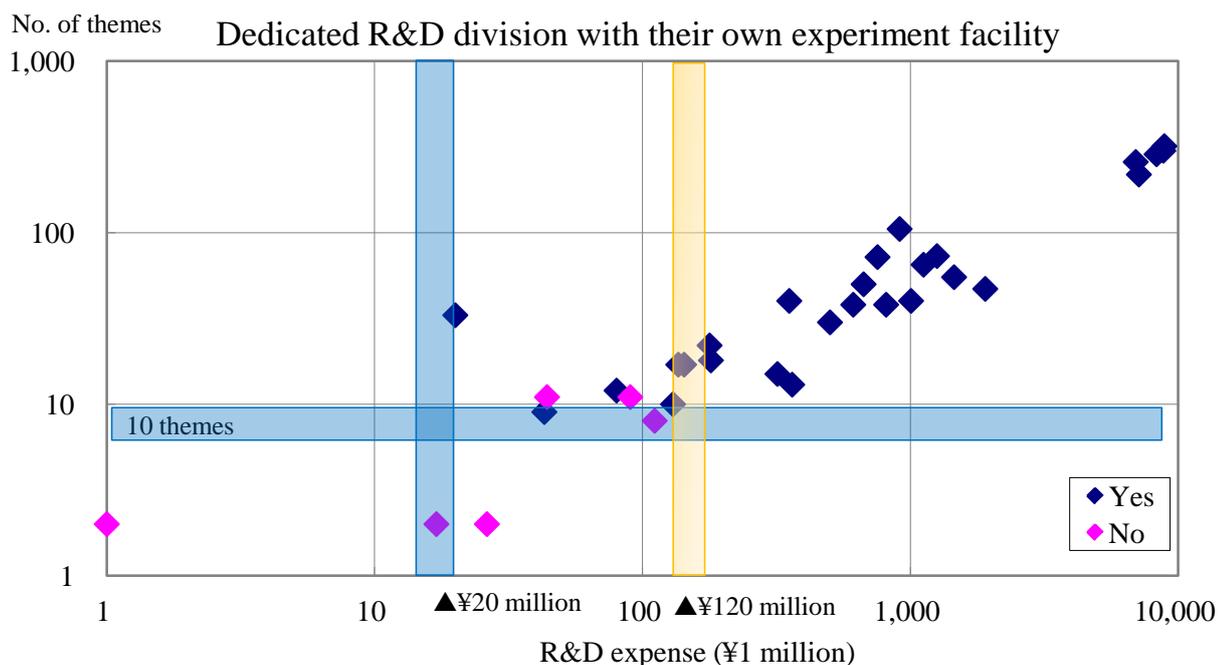


Dedicated R&D division with their own experiment facility

(No. of respondents: 36)

- Out of 36 companies that conduct R&D, 28 (78%) have dedicated R&D divisions having their own experiment facility.

According to the graph plotted by R&D expense and the number of themes, whether or not an R&D division has its own experiment facility may be determined in two factors, the number of themes and the R&D expense. To be specific, the borderline for the former for those having their own experiment facility is “10 themes.” The lower limit for those having their own experiment facility is ¥20 million, while the upper limit for those having none is ¥120 million.



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B. Organizational System for R&D

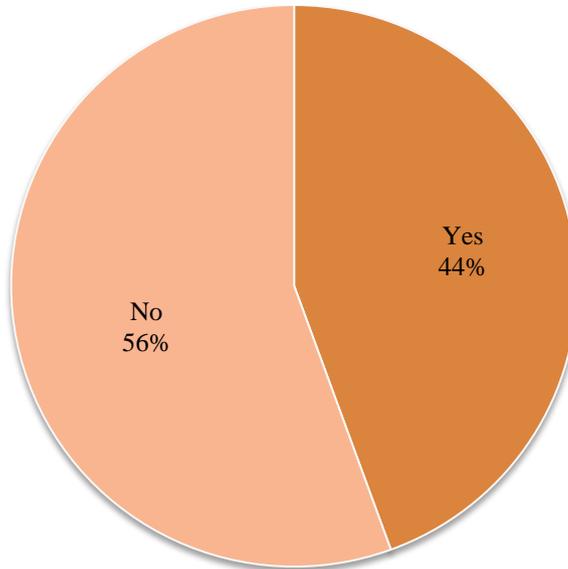
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B-3) Dedicated R&D division without their own experiment facility

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Dedicated R&D division without their own experiment facility

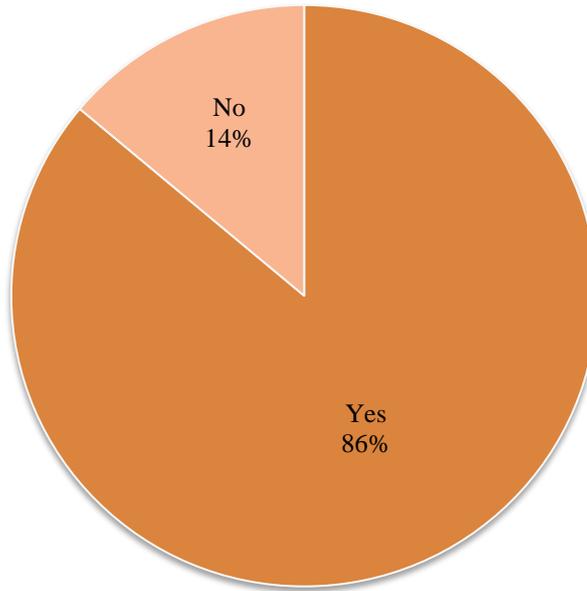
(No. of respondents: 36)

- 
- Out of 36 companies conducting R&D, 16, or 44%, answered their dedicated R&D division has no experiment facility.
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B-4) Division responsible for intellectual property management

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Division responsible for intellectual property management

(No. of respondents: 36)

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- Out of 36 companies conducting R&D, 31, or 86%, have divisions responsible for intellectual property management.
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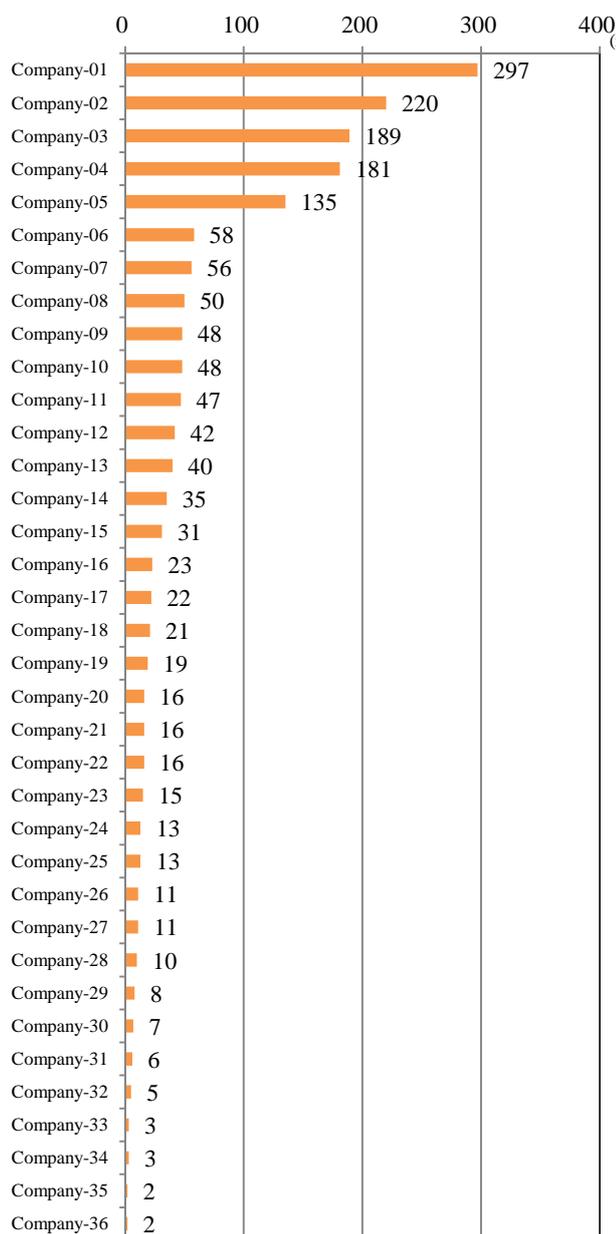
## B. Organizational System for R&D

### B-5) No. of researchers and the ratio of researchers to total employees \*

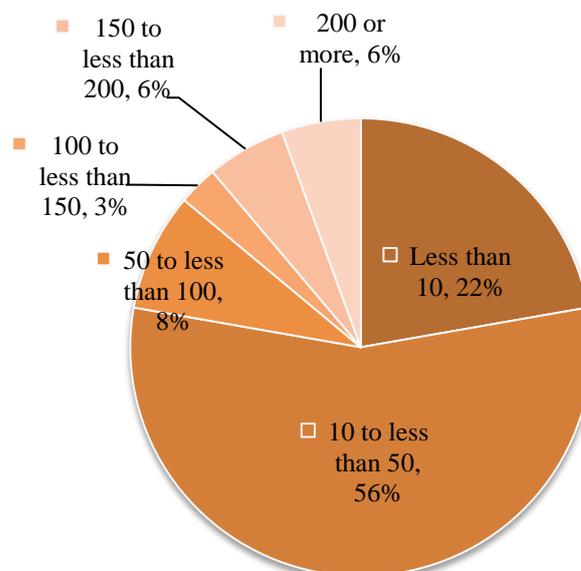
\*This survey applies to researchers not only working in technical laboratories but also employees who spend the majority of their service time in R&D.

This definition is almost the same as that of “those mainly engaged in research” as used in the questionnaire of the Ministry of Internal Affairs and Communications or that of “the number of researchers” as used in Nikkei Questionnaire.

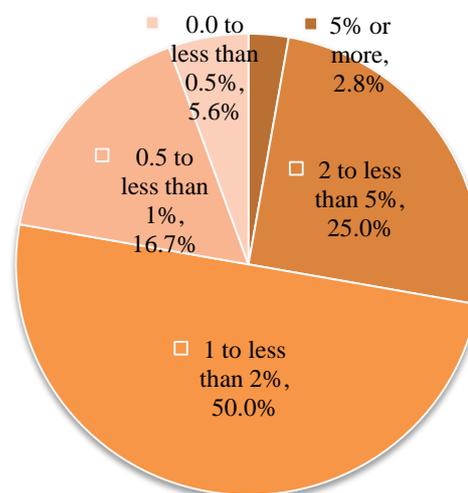
Companies conducting no R&D are excluded. (No. of subject companies: 36)



No. of researchers of each company



No. of researchers



Ratio of the number of researchers to the total number of employees

(No. of respondents: 36)

- The largest and smallest number of researchers is 297 and 2, with 48 as the average.
- The number of companies having 10 to 50 researchers is greatest, or 20 companies, which is about 56%.
- For the majority of companies, the ratio of researchers to all employees is about 1 to less than 2%, which accounts for about 50%.

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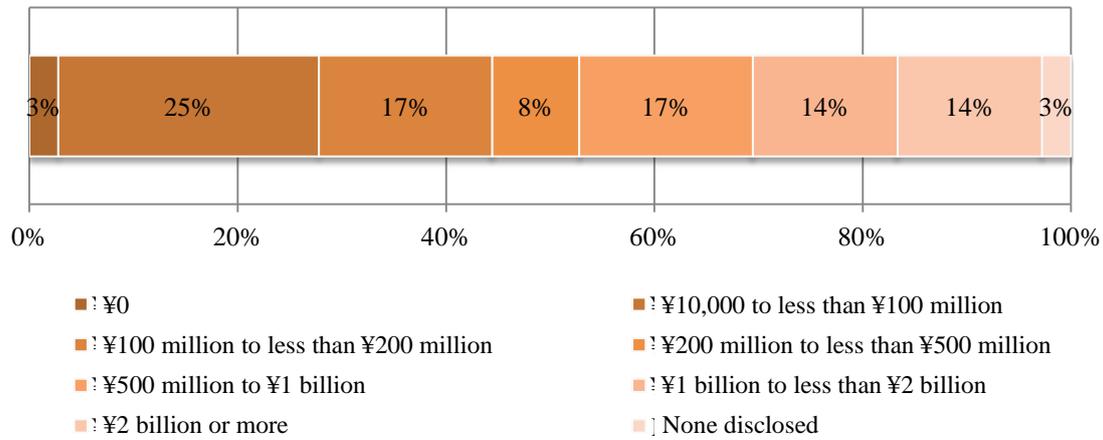
## C. R&D Expense

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### C-1) Expense incurred for the entire company (expense publicly announced)

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R&D expense

(No. of respondents: 36)

- The R&D expenses (publicly announced values) of all 36 respondent companies are graphically classified by the scale.
- ¥0 accounts for 3 % (one company), less than ¥100 million for 25% (9 companies), ¥100 million to less than ¥200 million for 17% (6), ¥200 million to less than ¥500 million for 8% (3), ¥500 million to less than ¥1 billion for 17% (6), ¥1 billion to less than ¥2 billion for 14% (5), not less than ¥2 billion for 14% (5), and no disclosed cost for 3% (one).

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## C. R&D Expense

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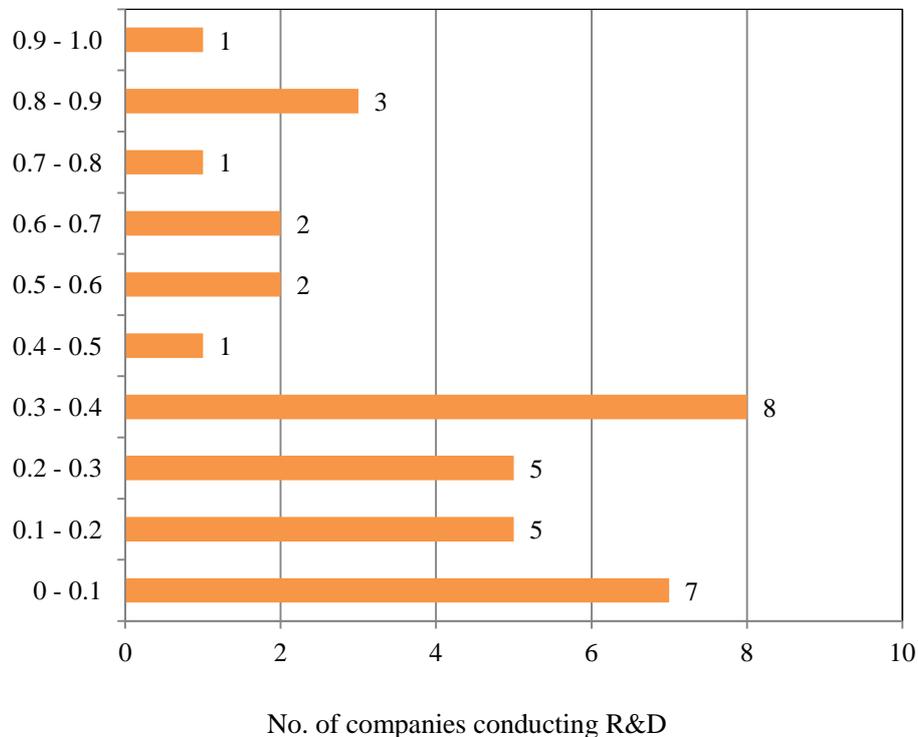
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### C-2) Ratio of 1) to sales volume

The ratio (%) of R&D expense is calculated as [C-1 R&D expense] / [A-2 sales volume].

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Ratio of R&D expense (%) to sales volume



(No. of respondents: 35)

- The ratios of R&D expenses (C-1) to the sales volumes (A-2) are plotted in a bar graph at an interval of 0.1%.
  - The graphically presented data are based on those of 35 companies excluding four companies not conducting R&D and one company not disclosing R&D expense.
  - Among 35 companies, the range from 0.3% to less than 0.4% contains the largest number of companies, or 8.
  - The range from 0 to less than 0.4% accounts for 71% or 25 companies.
  - A company whose ratio of R&D expense to sales volume is the highest is 0.92%.
  - The average (all R&D expenses / all sales volumes) over 35 companies is 0.56%.
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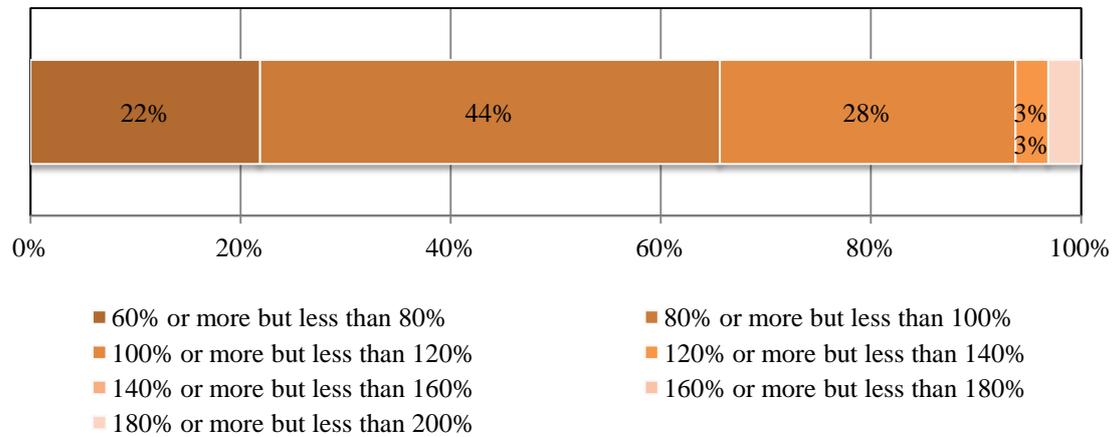
## C. R&D Expense

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### C-3) Ratio of 1) to that in the previous year

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The ratio of R&D to that in the previous year

(No. of respondents: 32)

- The average ratio of R&D expense to that in the previous year for 32 companies is 97%, with 198% as the highest and 69% as the lowest.
  - For the ratio of R&D to that of the previous year, the range of not less than 80% to below 100% accounts for the largest 44%, followed by the range of not less than 100% to below 120% accounting for 28%, the range from not less than 60% to below 80% for 22%, the range from not less than 120% to below 140% for 3%, and the range from not less than 180% to below 200% for 3%.
  - Companies whose ratio of R&D expense to that of the previous year increased account for 22%, those with no change for 13%, and those with a decreased ratio for 66%.
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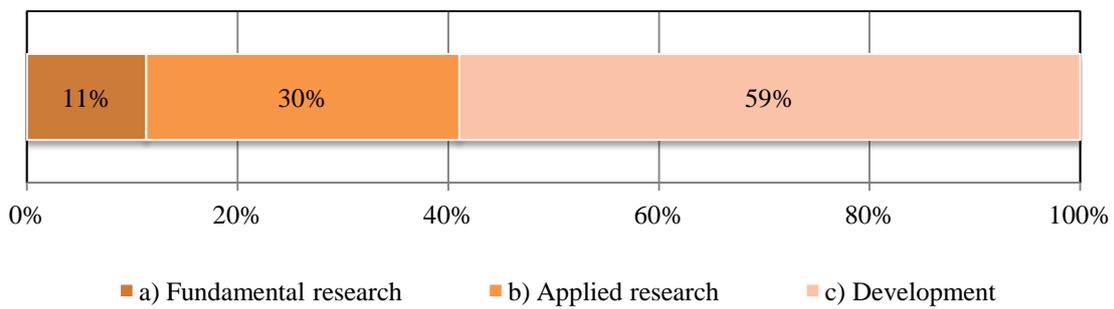
## C. R&D Expense

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### C-4) Percentages of fundamental research, applied research and development

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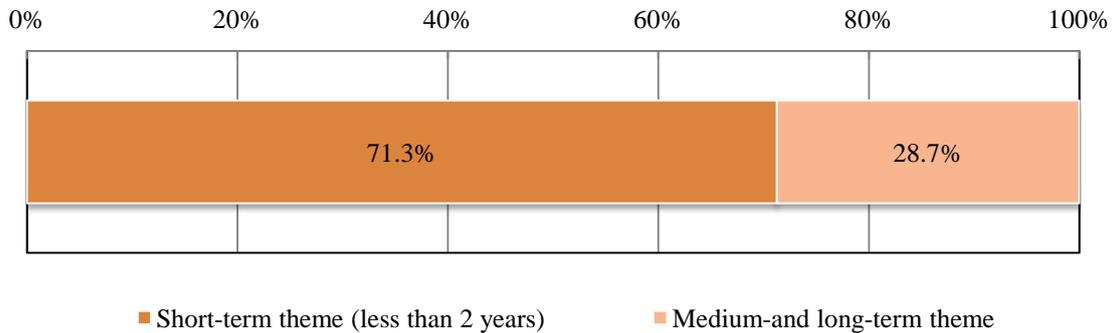


Percentages of R&D expense in fundamental research, applied research and development

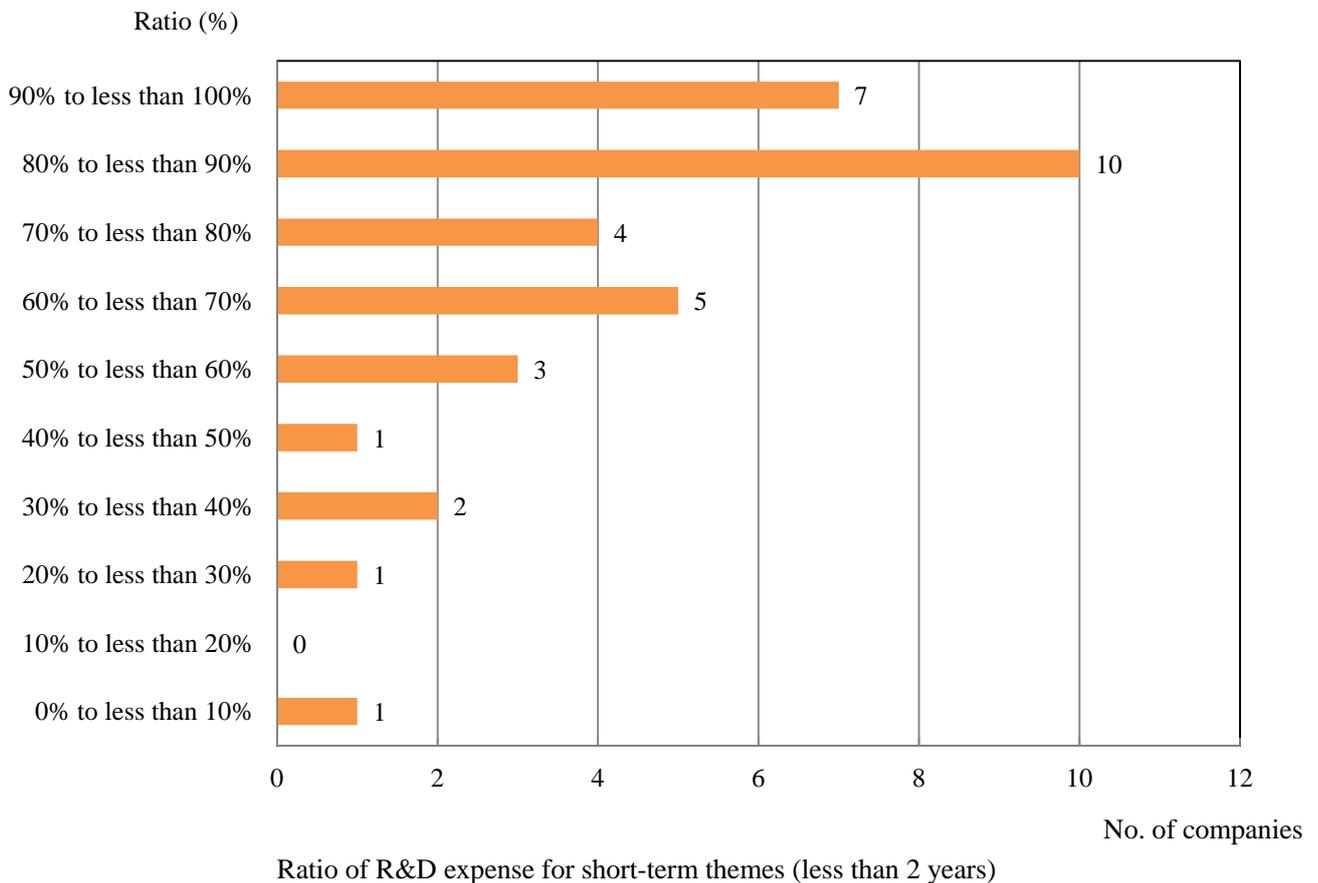
(No. of respondents: 35)

- 
- The percentages of R&D expense in fundamental research, applied research and development are calculated from the total of each amount supplied by 35 companies and graphically presented.
  - The average of each percentage is 11% for fundamental research, 30% for applied research and 59% for development.
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-

C-5) Ratio of R&D expense between short-term themes (less than 2 years) and medium- and long-term themes



Ratio of R&D expense between short-term themes (less than 2 years) and medium- and long-term themes



Ratio of R&D expense for short-term themes (less than 2 years)

(No. of respondents: 34)

- For the proportion of R&D expense for short-term themes (less than 2 years) and that for medium- and long-term themes for 34 companies, the former account for 71%, and the latter for 29% in terms of the amount of money.
- When the ratio for short-term themes is classified every 10%, the range from not less than 80% to less than 90% accounts for the largest number of companies, followed by not less than 90%.
- Companies whose ratio for medium- and long-term themes is 50% or over account for 15%.

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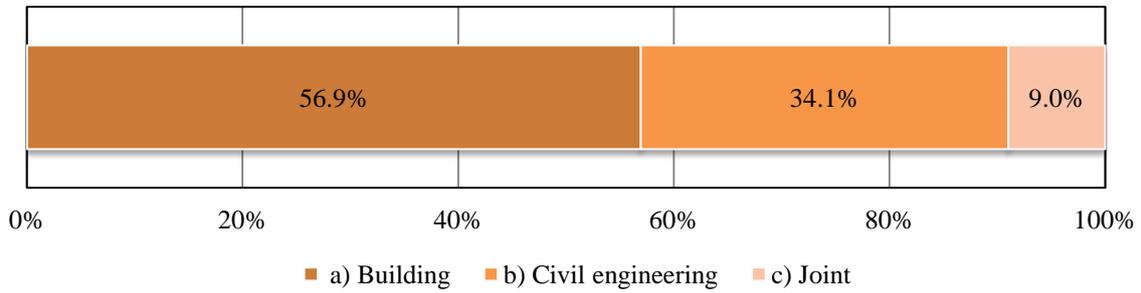
## C. R&D Expense

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### C-6) Percentages of building themes, civil engineering themes and joint themes

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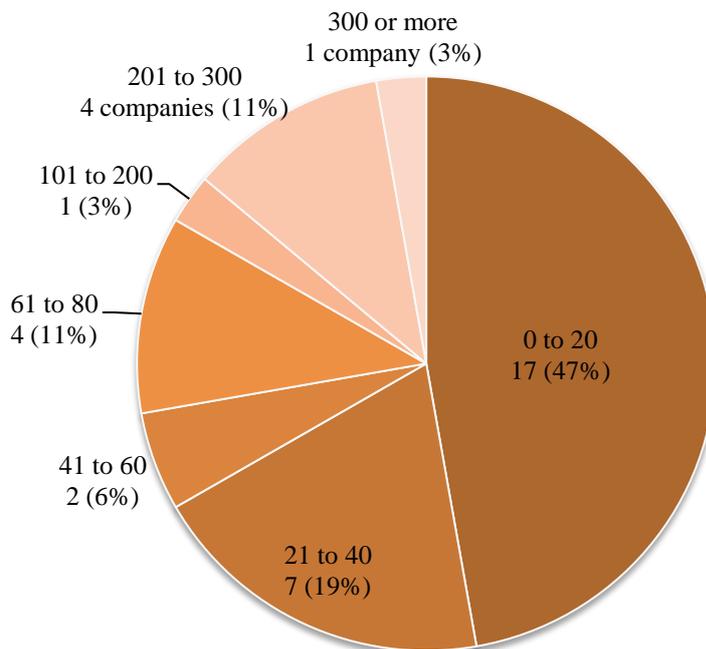


The average percentage of building themes, civil engineering themes and joint themes

(No. of respondents: 34)

- 
- 34 companies with publicly disclosed R&D expenses provided the thematic R&D expense proportion of building, civil engineering and joint themes, and the average is graphically presented.
  - For the R&D expense ratio for each of these themes, building themes account for 56.9%, civil engineering themes for 34.1%, and joint themes for 9.0%.
- 
-

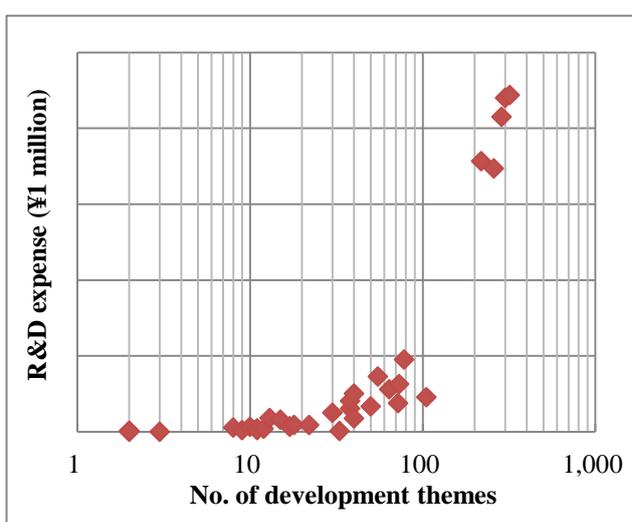
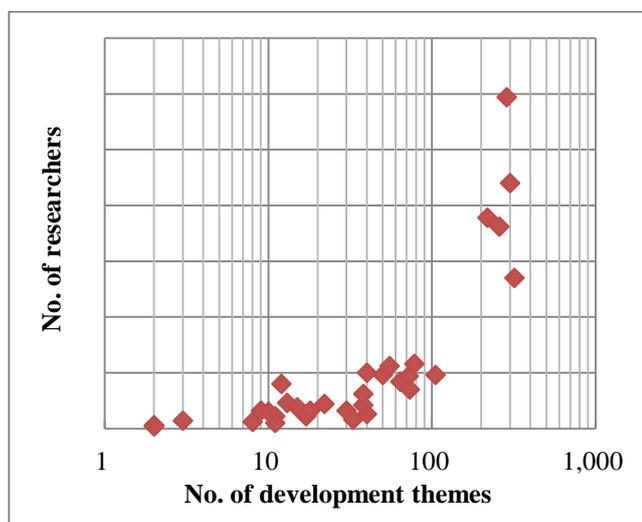
D-1) Total number of R&D themes



Total number of R&D themes

(No. of respondents: 36)

- The total number of R&D themes, pursued by 36 companies conducting R&D out of a total of 40 respondents is classified by the theme in a circle graph.
- 17 companies pursue not more than 20 themes, or 47%. 7 companies, or 19%, pursue 21 to 40 themes, 2 companies, or 6%, pursue 41 to 60 themes, 4 companies, or 11%, pursue 61 to 80 themes, and 6 companies, or 17%, pursue 100 or more themes.
- For the number of development themes per researcher, 1.3 is the average over 36 companies. There is no difference between the major five and the rest of the companies.
- The R&D expense per theme is ¥23.5 million on average for 34 companies. There is a large difference between the major five and the rest of the companies, with the former about ¥29 million on average and the latter about ¥13 million on average.



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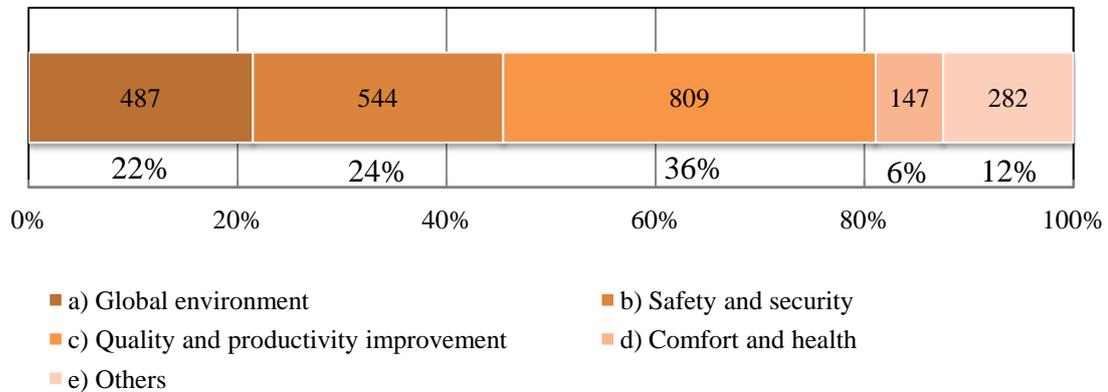
## D. R&D Themes

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### D-2) Percentages of R&D themes by the field

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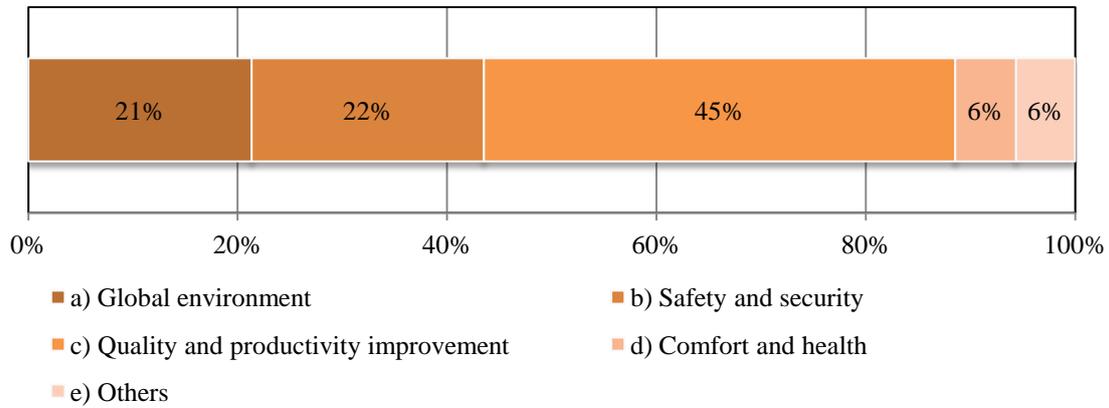
Percentage of R&D themes by the field

(No. of respondents: 36)

- 
- When a total of 2,269 R&D themes pursued by 36 companies are classified by the technical field, the proportion is 36% for quality and productivity improvement, 24% for safety and security, 22% for global environment, 6% for comfort and health, and 12% for others.
  - Although shown above is the overall theme balance, a company whose proportion of themes for a specific field is greater than others is assumed to put a premium on that field.
  - There are 17 out of 36 companies that have themes of a specific field exceeding 50% of all themes. Those companies are composed of 12 prioritizing quality and productivity improvement, 3 prioritizing global environment, and 3 prioritizing safety and security.
-

D-3) Percentage of R&D theme expense by the field

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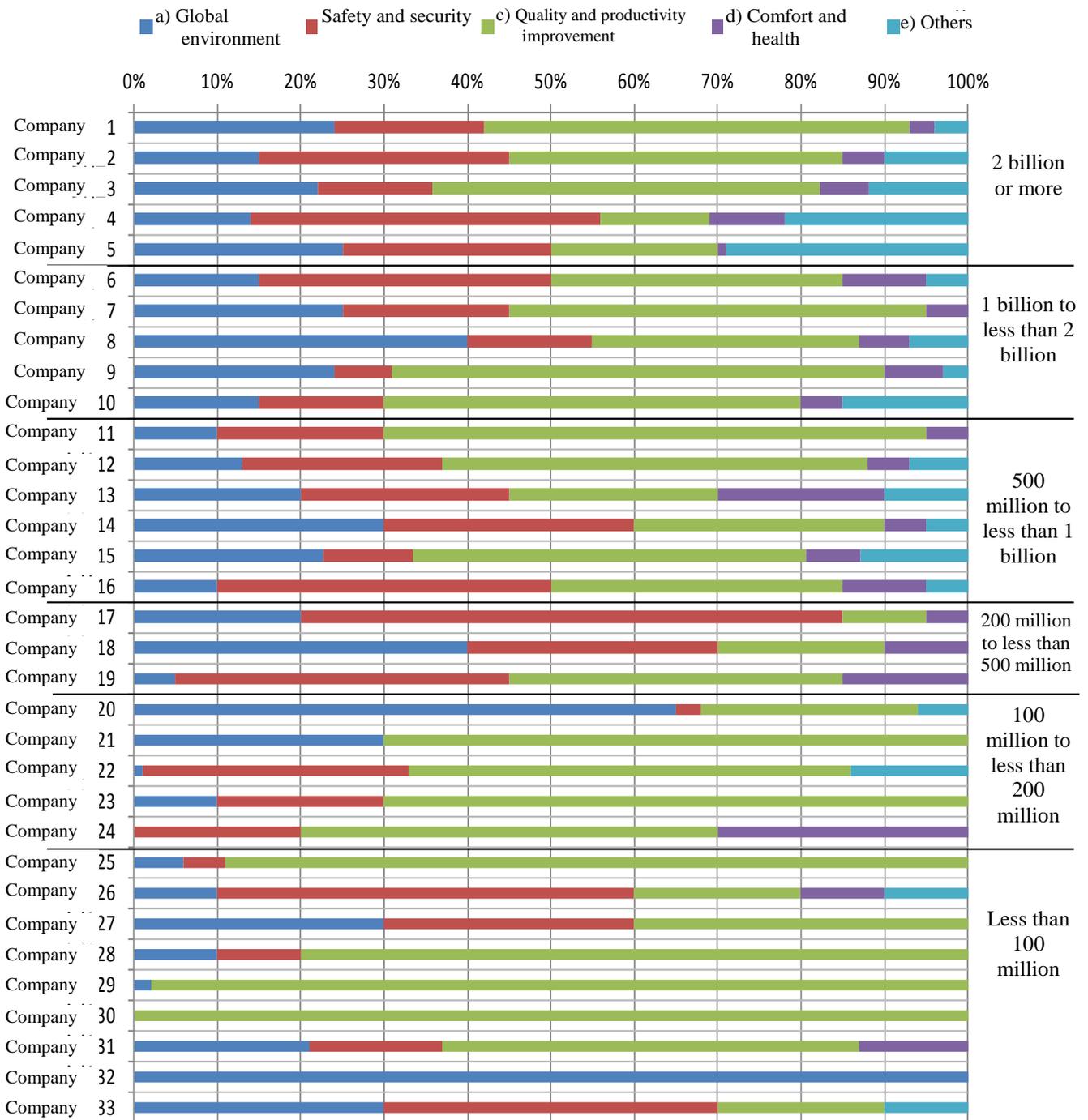
Percentage of R&D theme expense on each field

(No. of respondents: 33)

- 
- The data of 33 R&D conducting companies that answered the percentages of R&D spending by the field are summated by the field, and the proportion of all R&D expenses of the 33 companies by the field is analyzed in a graphical presentation.
  - R&D spending on quality and productivity improvement accounts for the largest percentage, or 45%, followed by the spending on safety and security for 22% and global environment for 21%.
-

D. R&D Themes

D-3) Percentage of R&D theme expense on each field



Percentage of R&D expense on each field (by the company)

(No. of respondents: 33)

- The data of 33 R&D conducting companies that answered the percentages of R&D spending by the field are summated by the field, and the fields pursued are arranged in descending order in terms of the amount of R&D expense in a graphical presentation.
- Comparing the data in the summation classification of C-1), companies having spent over ¥500 million on R&D put the budget on various fields, while those with less than ¥500 million tend to spend intensively on specific fields.

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D. R&D Themes

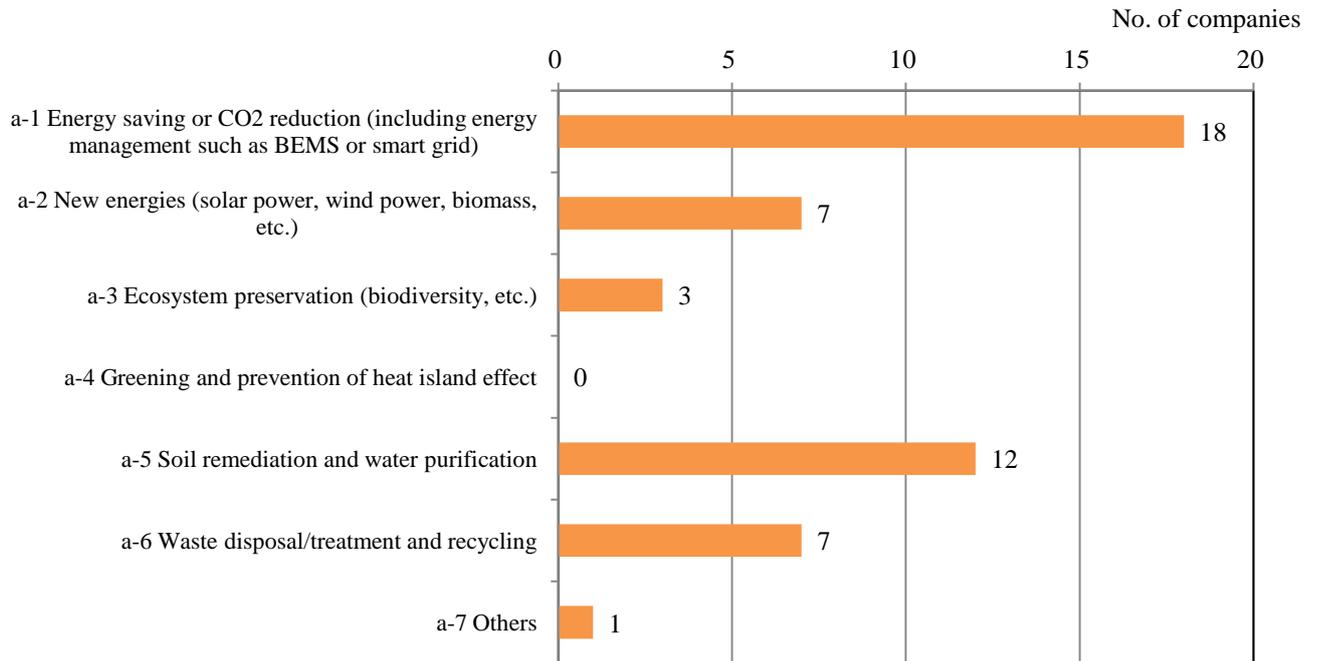
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D-4) Field of particular interest

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a) Global environment



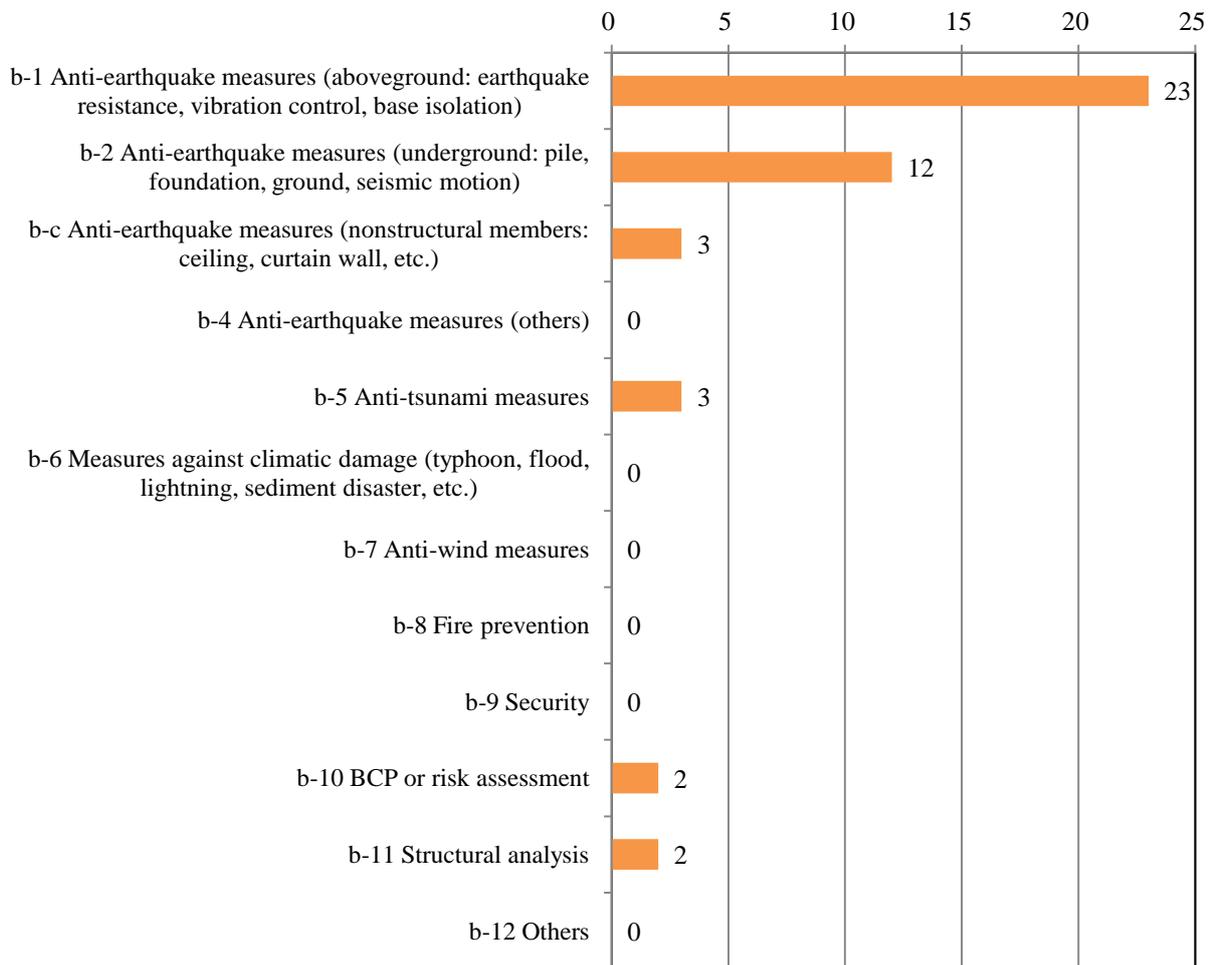
No. of themes by the category (global environment) (no. of companies)

(No. of respondents: 36)

- 
- For the field of global environment, the largest number of companies, or 18, cited as a field of interest “energy saving or CO2 reduction,” followed by 12 citing “soil remediation or water purification,” 7 each citing “new energy” and “waste disposal/treatment or recycling,” and 3 citing “ecosystem preservation.” One company gave “nuclear decontamination” as a focal field in the category of “others.”
- 
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D-4) Field of particular interest

b) Safety and security



No. of themes by the category (safety and security) (no. of companies)

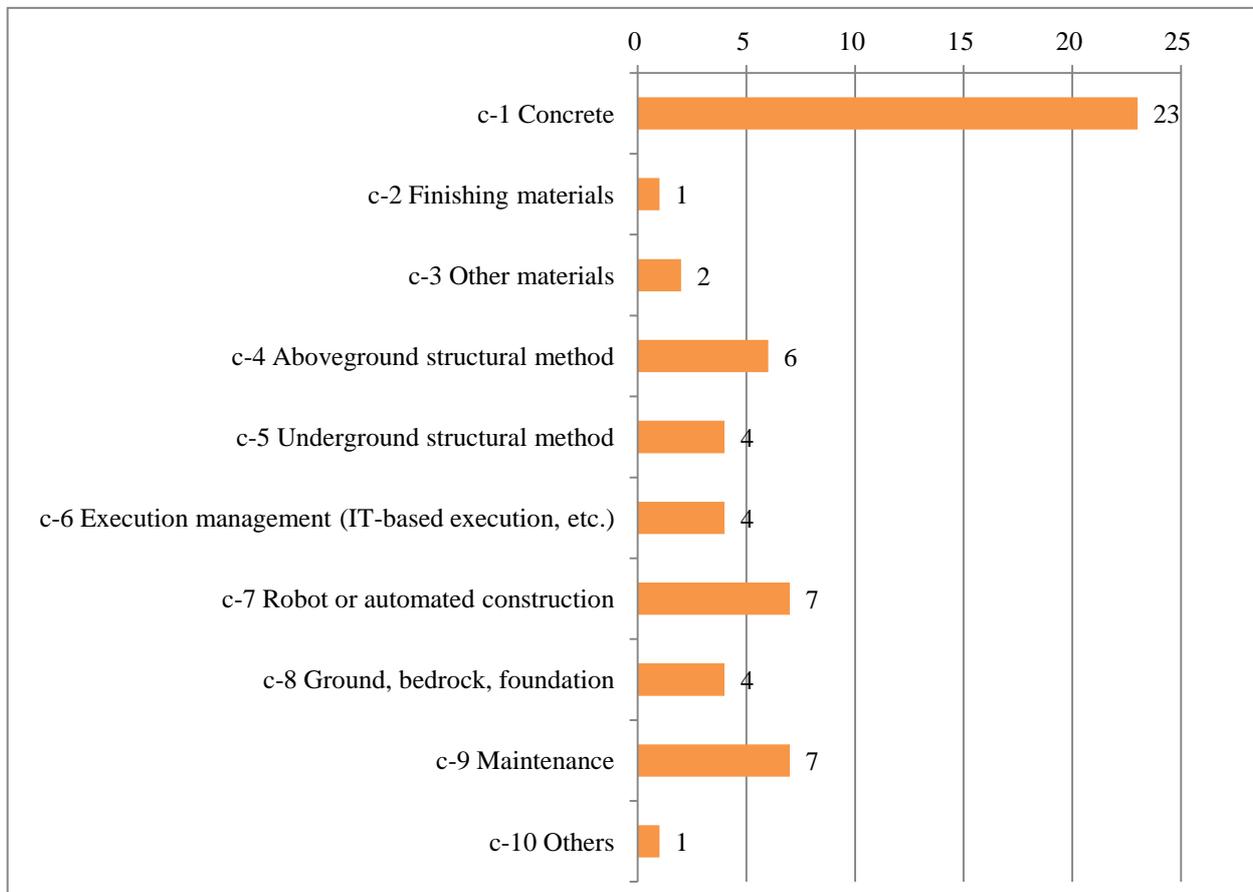
(No. of respondents: 36)

- For the field of safety and security, here are themes of popularity in the descending order: anti-earthquake measures (aboveground) pursued by 23 companies, anti-earthquake measures (underground) by 12, anti-earthquake measures (nonstructural members) by 3, and anti-tsunami measures by 3. All these total to 91% (41 companies). Other than the above, two gave “BCP and risk assessment,” and another two gave “structural analysis” as their focal fields.

D-4) Field of particular interest

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c) Quality and productivity improvement



No. of themes by the category (quality and productivity improvement) (no. of companies)

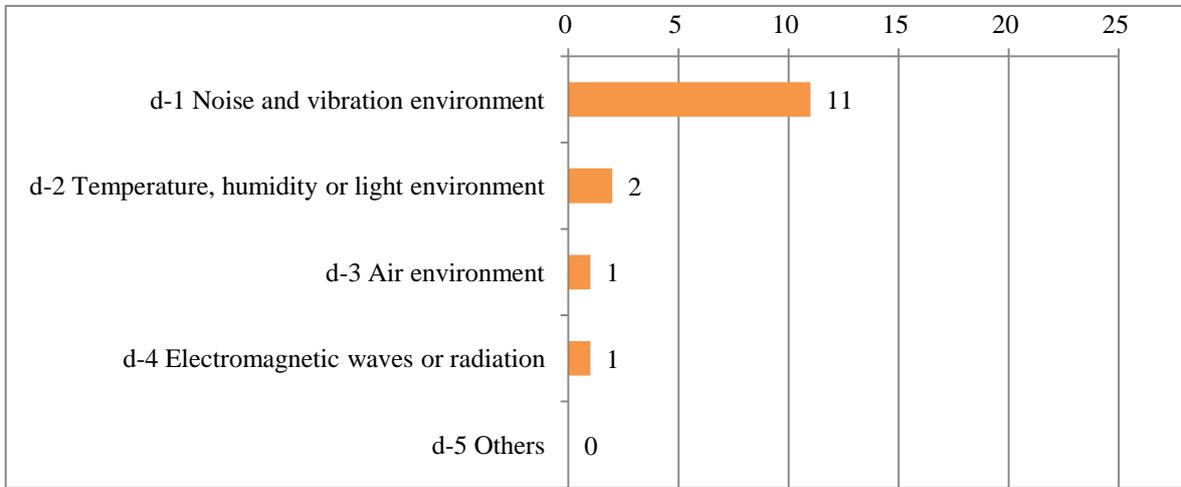
(No. of respondents: 36)

- 
- In the field of quality and productivity improvement, the largest number of companies, or 23, cited “concrete” as their field of interest, which is followed by seven companies citing “robot or automated construction” and “maintenance” and six citing “aboveground structural method.” For the category of others, “tile application method” is given by one company.
- 
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D-4) Field of particular interest

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d) Comfort and health



No. of themes by the category (comfort and health) (no. of companies)

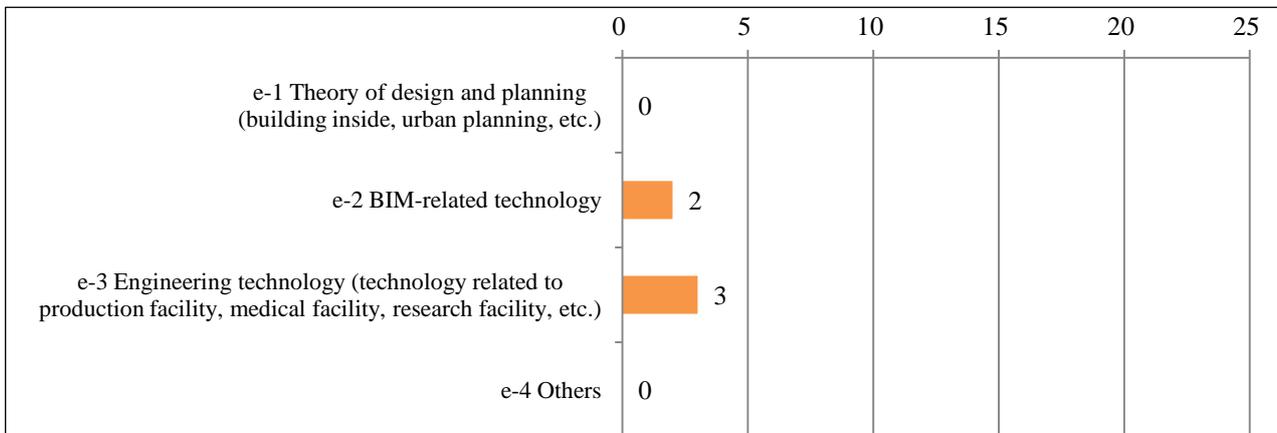
(No. of respondents: 36)

- 
- In the field of comfort and health, the largest number of companies, or 11, cited “noise and vibration environment” as their field of interest, which is followed by two companies citing “temperature, humidity, or light environment” and one each citing “air environment” and “electromagnetic waves or radiation,” respectively.
-

D-4) Field of particular interest

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e) Others



No. of themes by the category (others) (no. of companies)

(No. of respondents: 36)

- 
- In the field of “others,” three companies focus on engineering technology, and two on BIM-related technology.
- 

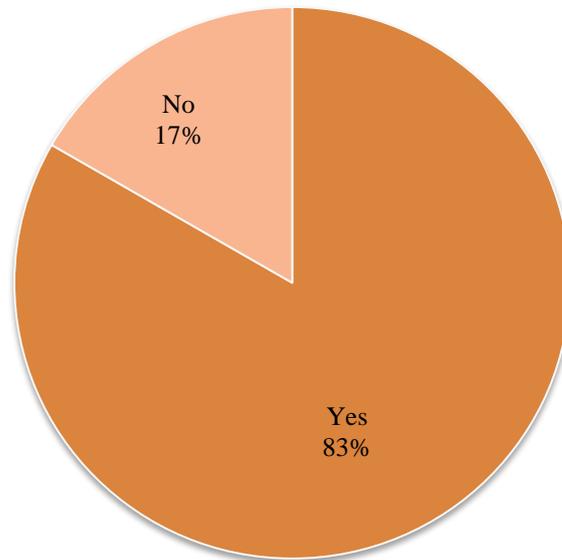
Analysis on “Fields of Particular Interest” in General

- Among all themes in all fields pursued by the respondent companies, the most popular ones are “b) Safety and security: anti-earthquake measures (aboveground)” and “c) Quality improvement and productivity improvement: concrete, each chosen by 23 companies. The second most popular is “a) Global environment: energy saving or CO2 reduction” chosen by 18 companies.
- For “nuclear decontamination,” it was not categorized into either the major category or sub category when this questionnaire was prepared, and was therefore categorized in various fields at the discretion of each company. In the next questionnaire, we intend to cite it as an independent item in either of the category.

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D-5) R&D themes on restoration from earthquake disaster

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R&D themes on restoration from earthquake disaster

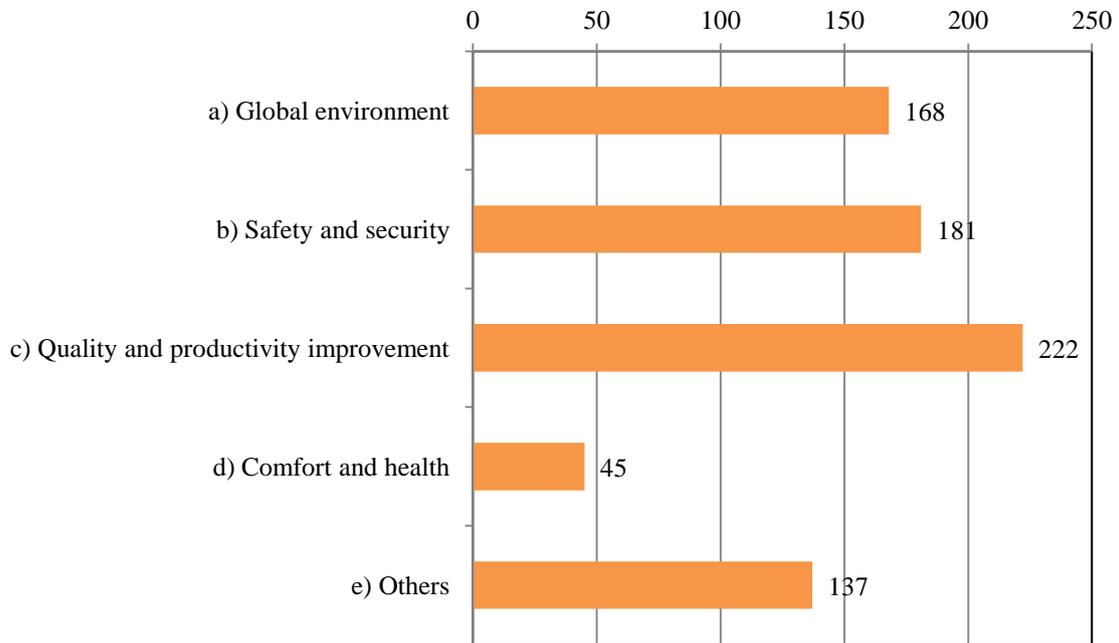
(No. of respondents: 36)

- 
- Among 36 companies conducting in-house R&D, 31 conduct R&D on restoration from earthquake disaster.
  - Most companies conduct R&D on restoration from earthquake disaster. Answers on the major R&D results in the past one year as in D-7) used such keywords as decontamination technology, seismic retrofit, base isolation,, anti-liquefaction measures, and anti-tsunami measures.
-

D-6) No. of information releases issued by the field in the past one year

“Releases” here include the information disclosed to the public such as news releases published in the official websites or press releases.

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No. of information releases issued by the field in the past one year

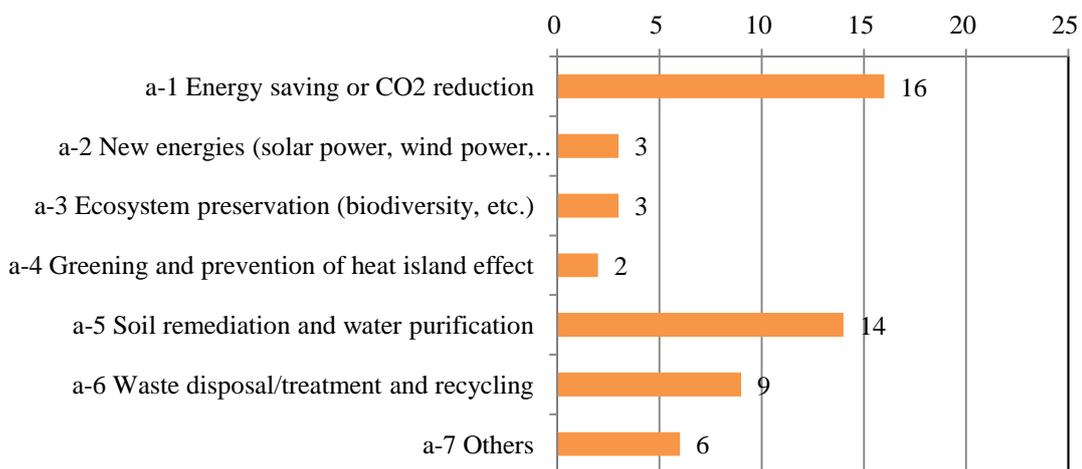
(Total number: 753)

- 
- The total number of releases is 753.
  - For the releases by the field, the most frequently covered field is c) Quality and productivity improvement, which is cited by 222 releases. The second most popular is b) Safety and security cited by 181, followed by a) Global environment by 168, and d) Comfort and health by 45. This result is understood to be the reflection of the interests of customers or society.
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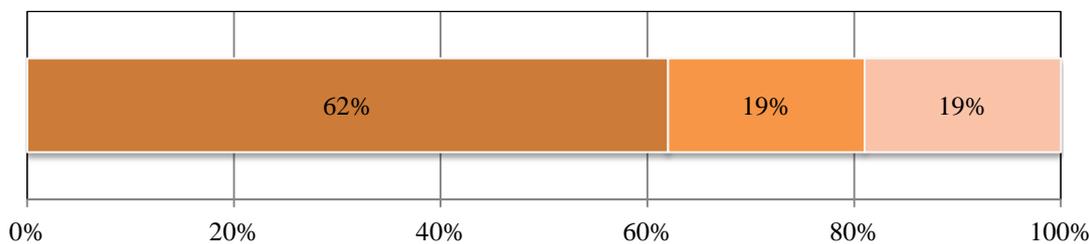
## D-7) Major R&amp;D results in the past one year

## a) Global environment

	Sub category	Specific names of technology
a-1	Energy saving or CO2 reduction Energy management including BEMS or smart grid	<ul style="list-style-type: none"> <li>• Technology for environmental-conscious design, first step toward ZEB realization “Basic Concept for 50% Energy-saving Building,” energy-saving technologies, and CO2 absorbing concrete</li> <li>• Simple LCC/LCCO2 evaluation tool; and PC power saving control system designed to reduce power consumption</li> <li>• Eco School; and fuel-saving operation guidance tool ECO-Dash</li> <li>• Lighting for grid system ceiling (O-GRID) “Eco Lumi LED”</li> <li>• Energy-saving thermal insulation system “ECO-NIS II”</li> <li>• Program designed to visualize CO2 reduction of condominium units</li> <li>• Development of CO2 reduction planning support tool</li> <li>• Warmer environment in cities, energy management technology, and energy-saving diagnosis technology</li> <li>• CO2 reduction calculation technology; and method for prevention of liquefaction by driving logs into the soft ground</li> <li>• Environmental-conscious office repair demonstration space “RECOffice”</li> </ul>
a-2	New energies including solar power, wind power, or biomass	<ul style="list-style-type: none"> <li>• Experiment of introduction of snow-cooling system to pig houses in stock farm and wind power generation on the ocean</li> <li>• General-purpose installation system for solar power panels “Cross Point Holder”</li> </ul>
a-3	Ecosystem preservation Biodiversity, etc.	<ul style="list-style-type: none"> <li>• Biodiversity-compatible technology; and biodiversity preservation technology</li> <li>• Research and development on water-front repair technology using sediments</li> </ul>
a-4	Greening and prevention of the heat island effect	<ul style="list-style-type: none"> <li>• Hydro recycling system for prevention of the heat island effect</li> <li>• Rooftop greening for heat island effect mitigation</li> </ul>
a-5	Soil remediation and water clarification	<ul style="list-style-type: none"> <li>• Development of soil remediation by chemical treatment, decontamination technology, ozone treatment, wastewater crystallization technology, and purification of oil-contained water</li> <li>• Development of “zeolite slurry” excellent in cesium absorption, and water decontamination</li> <li>• Technology for decontamination of contaminated soil using microbes</li> <li>• Soil decontamination system using biopiles</li> <li>• Decontamination of contaminated soil using high-performance cleaning equipment and volume reduction technology</li> <li>• Technology for treatment of wastewater generated during crude oil drilling; and technology for decontamination of fluorine-contaminated water (under development)</li> <li>• Technology for decontamination of soil contaminated by cyanogen compound; and volume reduction of radiation-contaminated soil</li> </ul>
a-6	Waste disposal/treatment or recycling	<ul style="list-style-type: none"> <li>• Recycling technology using industrial byproducts</li> <li>• Technology for evaluation of seepage control work of waste disposal site at the point of completion</li> <li>• “TSP-ECO method” designed to reduce construction sludge by up to 60%</li> <li>• Technology to turn magnesium oxide materials into slurry</li> <li>• R&amp;D on industrial byproduct recycling technology</li> <li>• Verification of applicability of embankment construction using waste earth generated from construction</li> <li>• Asbestos-containing building material treatment system</li> <li>• Utilization of site with dredged soil</li> <li>• Asbestos-containing building material treatment system</li> </ul>
a-7	Other evaluation tools	<ul style="list-style-type: none"> <li>• Air bubble excavation method</li> <li>• Lining surface reinforcement renewal system for small-section tunnels</li> <li>• Air bubble soil pillar line wall designed to remarkably reduce environmental loads</li> <li>• Service life evaluation technology and system for existing buildings</li> <li>• Radiation exposure reducer for radiation decontamination work</li> <li>• Environmentally friendly super high-rise building demolition system “Takenaka Hat Down Method”</li> </ul>



No. of themes by the category (global environment) (no. of companies)



■ Two or more results (22 companies) ■ One result (7 companies) ■ No result (7 companies)

Ratio of entries (global environment)

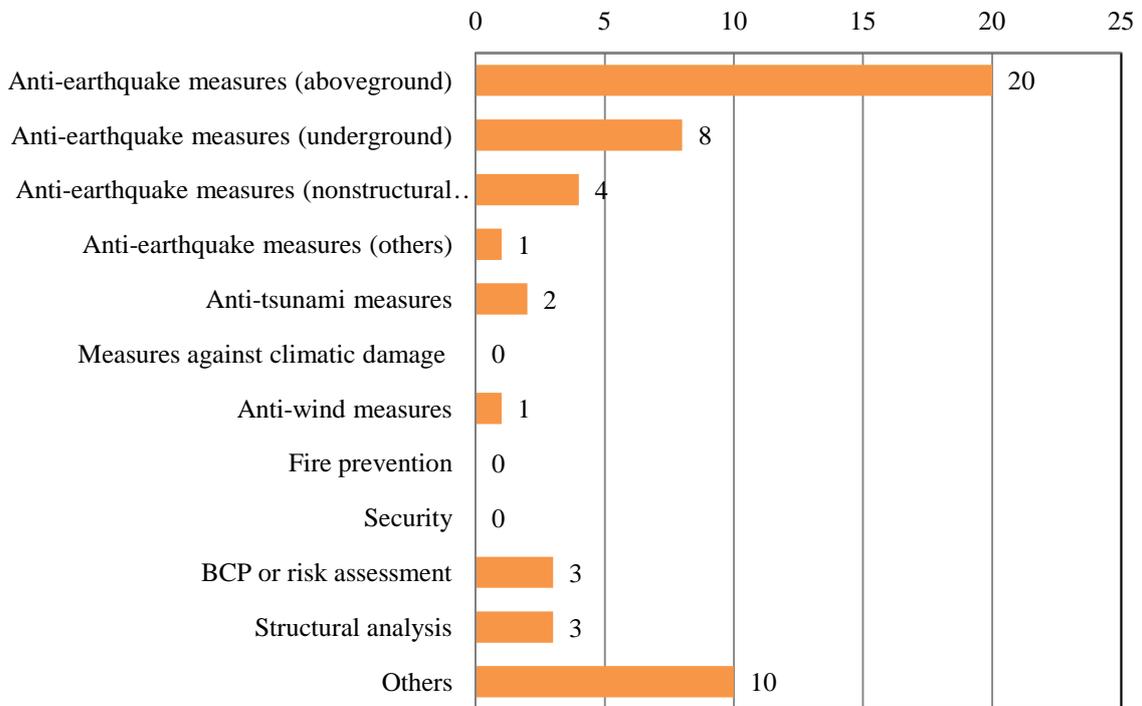
(No. of respondents: 36)

- Major R&D results in the field of “global environment” in the past one year are divided into seven as in the case of the sub category of D-4 so that specific technologies are itemized. The number of entries per category is also graphically summarized.
- There are 53 technologies in total. “Energy saving and CO2 reduction” is the most popular field, in which 16 companies produced R&D results. The second popular field is “soil remediation or water purification” covered by 14 companies, followed by “waste disposal/treatment and recycling” by 9, “others” by 6, “new energies” and “ecosystem preservation” by 3 each, and “greening and heat island effect prevention” by 2.

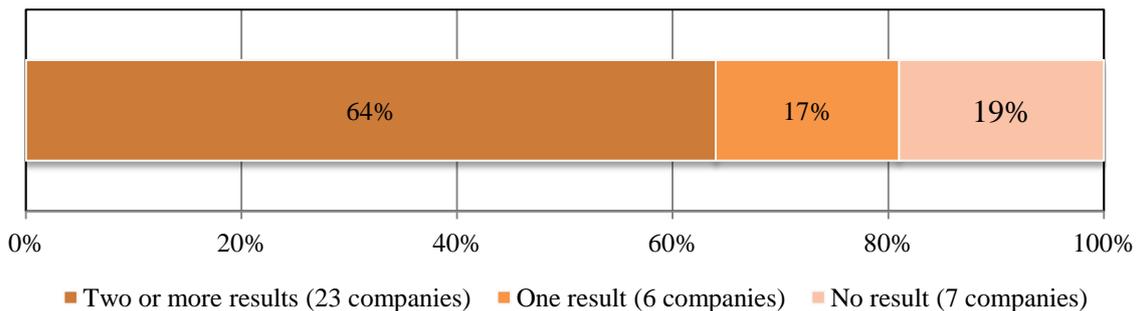
D-7) Major R&D results in the past one year

b) Safety and security

	Sub category	Specific names of technology
b-1	Anti-earthquake measures (aboveground)	<ul style="list-style-type: none"> <li>• Seismic base isolation using large-diameter piles, vibration control with external dampers</li> <li>• Seismic reinforcement of existing buildings</li> <li>• Low-noise, low-vibration seismic retrofit and vibration-controlled structural system</li> <li>• Seismic retrofit of plate-shaped housing buildings</li> <li>• External vibration control reinforcement, out-of-plane shear reinforcement</li> <li>• Vibration control structural system and vibration control</li> <li>• Seismic retrofit with reinforced masonry blocks</li> <li>• Seismic retrofit of bridge piers</li> <li>• Seismic retrofit of existing buildings</li> <li>• Measures to cope with the damage of long-frequency vibration to super high-rise buildings and vibration control method</li> <li>• Seismic retrofit of traditional wooden buildings</li> <li>• Seismic retrofit of buildings with seismic base isolation while keeping the buildings available for use</li> <li>• Seismic reinforcement with seismic frames with slabs and reinforced vibration control</li> <li>• Seismic retrofit with external non-shrinkage concrete</li> </ul>
b-2	Anti-earthquake measures (underground)	<ul style="list-style-type: none"> <li>• High-density earthquake observation, ground microvibration prediction</li> <li>• Earthquake analysis program</li> <li>• Measures to cope with liquefaction, underground spreading excavation ground improvement</li> <li>• Foundation pile seismic reinforcement</li> <li>• Flow closing piles, liquefaction countermeasure</li> </ul>
b-3	Anti-earthquake measures (nonstructural members)	<ul style="list-style-type: none"> <li>• Earthquake resistant ceiling, ceiling seismic retrofit, and structural system to prevent fall of ceilings of production facility</li> <li>• Seismic retrofit of existing ceilings</li> </ul>
b-4	Anti-earthquake measures (others)	<ul style="list-style-type: none"> <li>• Seismic diagnosis of wooden buildings</li> </ul>
b-5	Anti-tsunami measure	<ul style="list-style-type: none"> <li>• Evacuation buildings in the event of tsunami and breakwater anchor reinforcement</li> </ul>
b-6	Measures against climatic damage	
b-7	Anti-wind measures	<ul style="list-style-type: none"> <li>• Balcony wind pressure technology</li> </ul>
b-8	Fire prevention	
b-9	Security	
b-10	BCP and risk assessment	<ul style="list-style-type: none"> <li>• General disaster prevention diagnosis system, survey and diagnosis technology, and deterioration survey and repair planning tool</li> </ul>
b-11	Structural analysis	<ul style="list-style-type: none"> <li>• Time-series response analysis and stability evaluation technique using composite external forces</li> <li>• Design of high-rise RC structure</li> </ul>
b-12	Others	<ul style="list-style-type: none"> <li>• Radiation decontamination and radiation decontamination technology</li> <li>• High-performance welding technique</li> <li>• Buckling restriction brace</li> <li>• Steel brace buckling reinforcement</li> <li>• New PC method</li> <li>• Large space structure and emergency drinking water generation system</li> <li>• Power-saving safety equipment using piezoelectric ceramic</li> <li>• Vessel safety monitoring</li> </ul>



No. of themes by the category (safety and security) (no. of companies)



Ratio of the number of entries (safety and security)

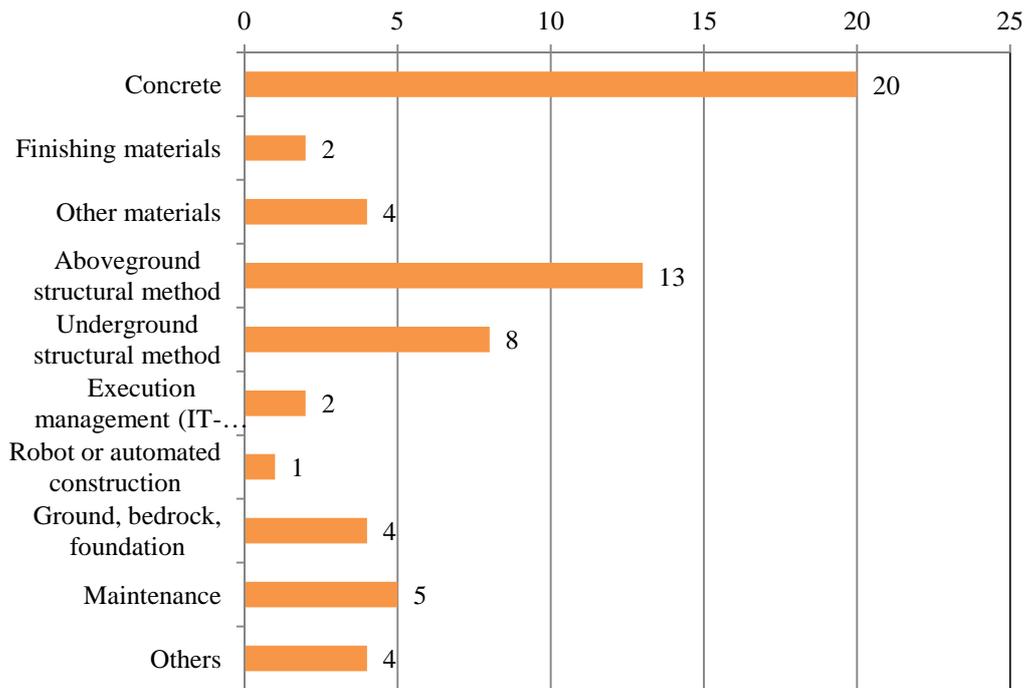
(No. of respondents: 36)

- Of 12 fields of “safety and security” in the sub category, the names of specific technologies are put together in a list. The number of technologies per field and the ratio of the number of entries for each company are graphically summarized.
- Of 36 companies conducting R&D, 29 made entries in the field of “safety and security,” and the total number of entries is 52.
- In the sub sub category of “safety and security,” the respondents cite 20 technical results, the largest number, in anti-earthquake measures (aboveground).
- 23 companies, or 64%, reported they had two technical results. 6 companies, or 17%, came up with one result. 81% of all the companies conduct R&D in the field of “safety and security.”

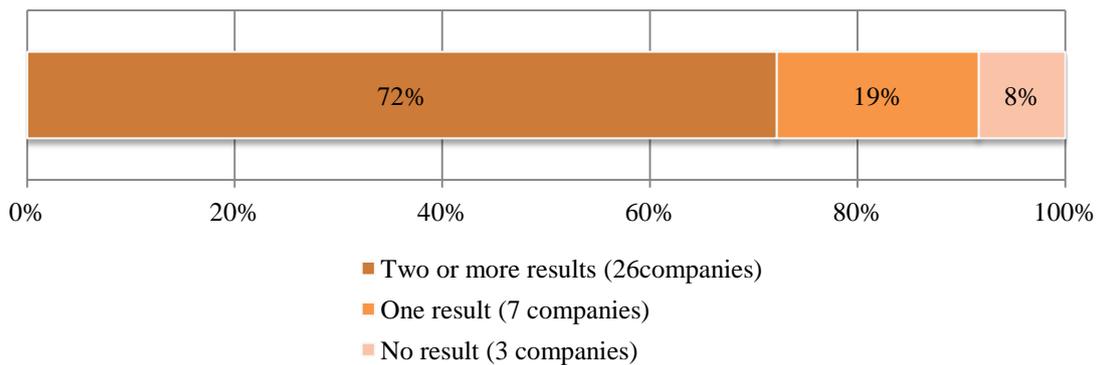
## D-7) Major R&amp;D results in the past one year

## c) Quality and productivity improvement

	Sub category	Specific names of technology
c-1	Concrete	<ul style="list-style-type: none"> <li>• Technology to enhance quality of concrete structures and concrete quality control technique</li> <li>• Method to cure floor slabs for prevention of cracking and concrete cracking control technology</li> <li>• Deck slab cracking control technology, analytic review of concrete slab expansion joints</li> <li>• Soaking curing method “Aqua Curtain” and concrete curing formwork</li> <li>• Super high-strength concrete (3 entries) and expanded application of nonshrinkage high-flowing concrete</li> <li>• Improvement of concrete durability and method of lining concrete curing</li> <li>• Lining concrete removal timing judgment system (T-JUDG system)</li> <li>• Medium-flowing concrete (three entries) including thickener-based medium-flowing concrete Smoothcrete</li> <li>• Lining end reinforcement with embedded fiber sheets (T-FREG method)</li> <li>• Self-propelled lining concrete wet curing system</li> </ul>
c-2	Finishing materials	<ul style="list-style-type: none"> <li>• Measure to ensure long-term guarantee of tile-finishing method</li> <li>• Paint to elongate the service life of reinforced concrete building “Acrycept ® method”</li> </ul>
c-3	Other materials	<ul style="list-style-type: none"> <li>• Fire resistance of thermal insulant and cover repairing material in cold region tunnels</li> <li>• Introduction of CAM to production of steel bridge composite slabs</li> </ul>
c-4	Aboveground structural method	<ul style="list-style-type: none"> <li>• Hybrid PCa method, hybrid structural method, and column RC beam S structural method x 5</li> <li>• CFT construction technology; and control of cracking on seismic walls</li> <li>• Unembedded horizontal rebar RC seismic wall method; and dry industrialization system of nonstructural walls</li> <li>• Anti-earthquake method to prevent external wall damage of reinforced concrete buildings</li> <li>• Special erection small beam for distribution facilities “e-String Beam”</li> </ul>
c-5	Underground structural method	<ul style="list-style-type: none"> <li>• Two entries in large-opening foundation beam method x 2; and knotted cast-in-situ concrete pile</li> <li>• Underground grade separation structural method</li> <li>• Closed rectangular and curved pipe roofing method using twin headers</li> <li>• Load-in/out of large materials and equipment in pneumatic caissons</li> <li>• Propulsion device for shield machine, dual shield method</li> </ul>
c-6	Execution management (IT-based execution, etc.)	<ul style="list-style-type: none"> <li>• Measuring device to reduce concrete strain measuring cost</li> <li>• Construction management system using iPad</li> </ul>
c-7	Robot or automated construction	<ul style="list-style-type: none"> <li>• Unmanned pneumatic caisson</li> </ul>
c-8	Ground, bedrock, foundation	<ul style="list-style-type: none"> <li>• Tunnel ground survey method; and research on the effect of improvement by injection method</li> <li>• Barrier material production system for radioactive wastes “Mist-Blender”</li> <li>• Preparation, testing, improvement and verification of monolithic twister</li> </ul>
c-9	Maintenance	<ul style="list-style-type: none"> <li>• Research on deterioration prediction and life cycle cost of structures</li> <li>• Basalt fiber reinforcement method; and absorbing self-propelled concrete wall surface chipping machine</li> <li>• ADOX 1380 W (epoxy resin concrete repairing material for cold region)</li> <li>• Single-side access elastic wave tomography</li> </ul>
c-10	Others	<ul style="list-style-type: none"> <li>• Two entries of super high-rise demolition method x 2; and silencer for natural ventilation openings</li> <li>• 3D simulation system with which a person can have a simulated experience of seeing the inside of a building</li> </ul>



No. of themes by the category (quality and productivity improvement) (no. of companies)



Ratio of the number of entries (quality and productivity improvement)

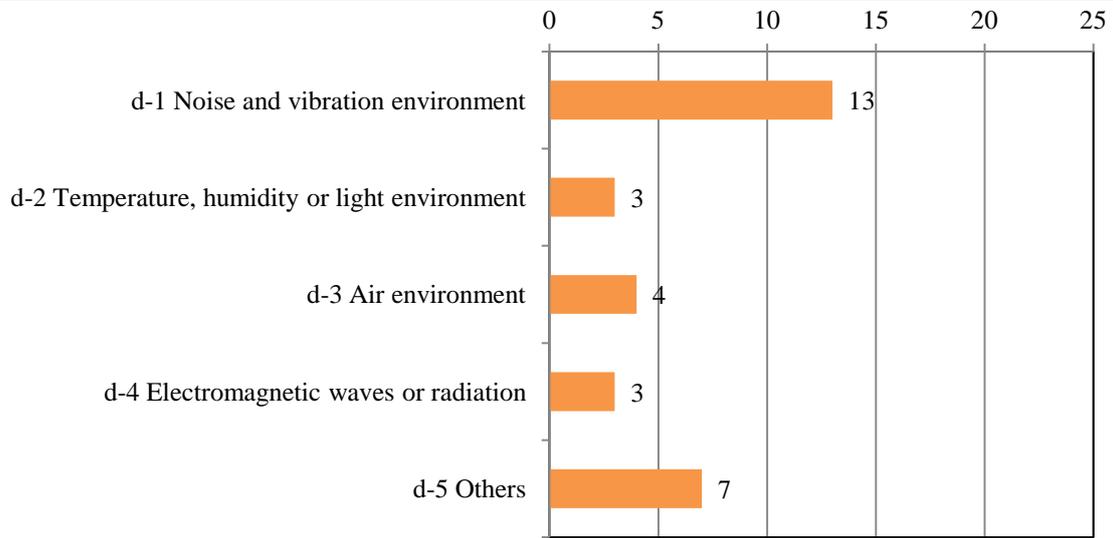
(No. of respondents: 35)

- The major R&D results achieved in the field of “quality and productivity improvement” in the past one year are classified into 10 categories as in the case of the sub category of D-4, and the specific technologies are summarized in a table. The number of technologies per field and the ratio of the number of entries for each company are graphically summarized.
- There are 63 entries in total. The largest number of entries was given to concrete, or 20, followed by aboveground structural method, or 13, and underground structural method, 8.
- Out of 36 companies conducting R&D, as many as 33 companies (92%) disclosed their major R&D results in “quality and productivity improvement” (including 72% for two or more entries and 19% for one entry). It shows many companies are trying hard to tackle R&D on “quality and productivity improvement,” the essence of manufacturing.

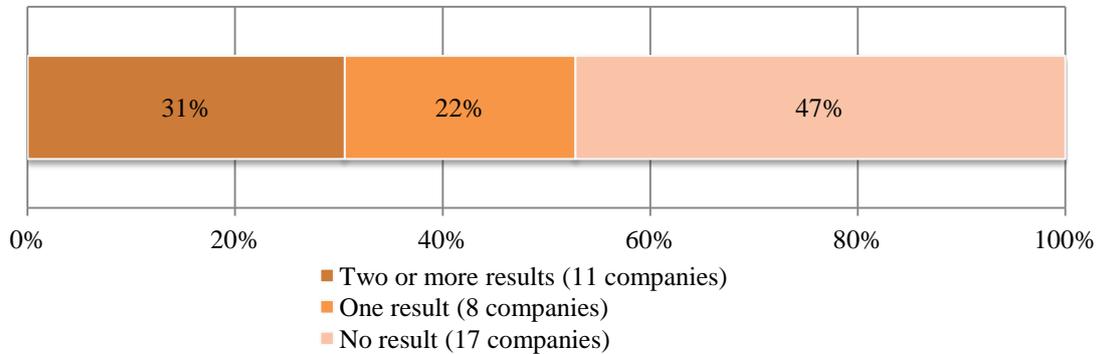
D-7) Major R&D results in the past one year

d) Comfort and health

	Sub category	Specific names of technology
d-1	Noise and vibration environment	<ul style="list-style-type: none"> <li>• Research on development of advanced floor vibration prediction</li> <li>• Silencer of low frequency noise</li> <li>• Development of heavy floor impact sound level reducing technique for collective housing</li> <li>• Highly sound-insulating dry double flooring</li> <li>• Low noise and low vibration foundation dismantling method</li> <li>• Development of noise prediction method during work while the building is kept usable</li> <li>• System for evaluation of heavy floor impact noise screening performance</li> <li>• Tunnel blasting low frequency silencer “Blast Silencer”</li> <li>• Development of work noise and vibration control technology</li> <li>• Work vehicle operation management system</li> <li>• Renewal work noise prediction system</li> <li>• Development of vibration prediction simulation technology; and development of noise prediction simulation technology</li> <li>• Environmental vibration simulator “Yure Judge”</li> </ul>
d-2	Temperature, humidity or light environment	<ul style="list-style-type: none"> <li>• Development of radiant cooling and heating system</li> <li>• Task ambient lighting and air-conditioning</li> <li>• Development of indoor warmer environment design support technology</li> </ul>
d-3	Air environment	<ul style="list-style-type: none"> <li>• TVOC countermeasure technology</li> <li>• Quantitative verification of the effect of microbial control in indoor space</li> <li>• Floor chamber air-conditioning system</li> <li>• Carbon nanotube scattering evaluation system</li> </ul>
d-4	Electromagnetic waves or radiation	<ul style="list-style-type: none"> <li>• Radiation shielding analysis technique</li> <li>• Electromagnetic shield</li> <li>• Detoxification of asbestos-containing building materials using overheated steam; and commercialization of recycling technology</li> </ul>
d-5	Others	<ul style="list-style-type: none"> <li>• Development of plate-shaped condo with open view SuKKiT3</li> <li>• Ease of work and energy saving both satisfied by “SmartLifeOffice®”</li> <li>• Development of next-generation condo with changeability, disaster prevention and the environment taken into consideration</li> <li>• Technology to reduce the volume of contaminated soil</li> <li>• Development of balcony with enhanced ease of use “e-Balcony”</li> <li>• Development of the elderly watching system</li> <li>• Development of HAM-J method capable of easily renewing vertical drain pipes</li> </ul>



No. of themes by the category (comfort and health) (no. of companies)



Ratio of the number of entries (comfort and health)

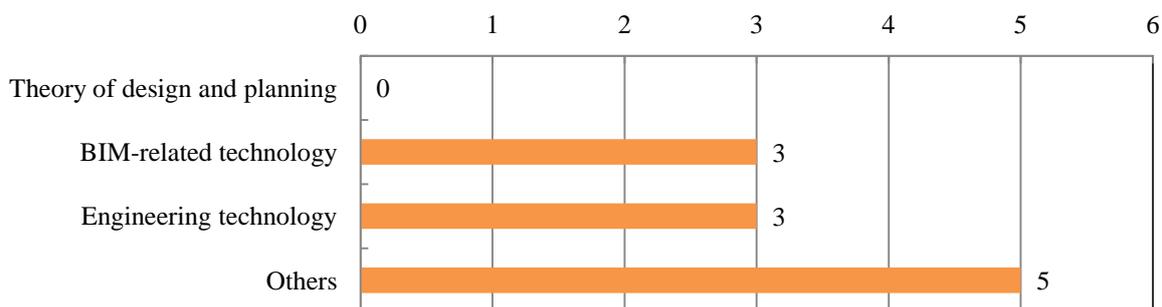
(No. of respondents: 36)

- Major R&D results in the field of “comfort and health” in the past one year are divided into five categories as in the case of the sub category of D-4, and the names of specific technologies are itemized. The number of technologies per field and the ratio of the number of entries for each company are graphically summarized.
- There are 30 entries in total. The most popular category is noise and vibration environment, or 13 entries. Seven entries are made in other areas. This indicates a wide variety of research and development is conducted.
- Out of 36 companies conducting R&D, 19 gave their major R&D results in the field of “comfort and health,” which is 53% (including 22% for one entry and 31% for two entries). Nearly half of all the companies, or 47%, show no result.

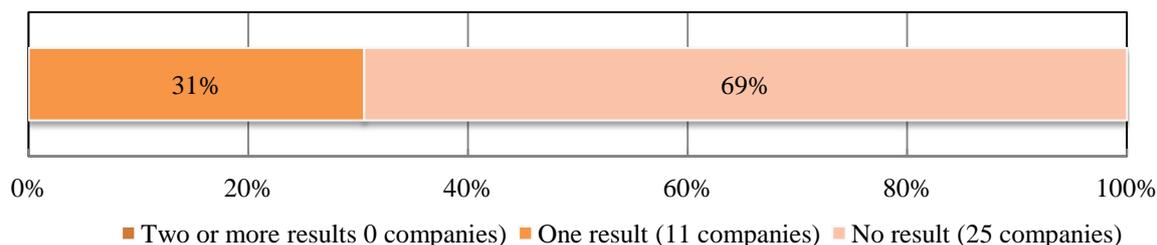
D-7) Major R&D results in the past one year

e) Others

	Sub category	Specific names of technology
e-1	Theory of design and planning (building inside, city planning, etc.)	
e-2	BIM-related technology	<ul style="list-style-type: none"> <li>• BIM pilot PJ</li> <li>• Techniques capable of using BIM</li> <li>• Development of relevant techniques for introduction of BIM</li> </ul>
e-3	Engineering technology (technology related to production facility, medical facility, or research facility)	<ul style="list-style-type: none"> <li>• Closed plant production facility simulation</li> <li>• Clean room production environment control technology</li> <li>• Sound reproduction system with concert hall model</li> </ul>
e-4	Others	<ul style="list-style-type: none"> <li>• Waste disposal/treatment system</li> <li>• Commercialization of lime cake recycling technology</li> <li>• Development of radiation-contaminated soil decontamination system</li> <li>• Development of concrete capable of screening radiation</li> <li>• Fukushima prefecture decontamination technology demonstration project</li> </ul>



No. of themes by the category (others) (no. of companies)



Ratio of the no. of entries (others)

(No. of respondents: 36)

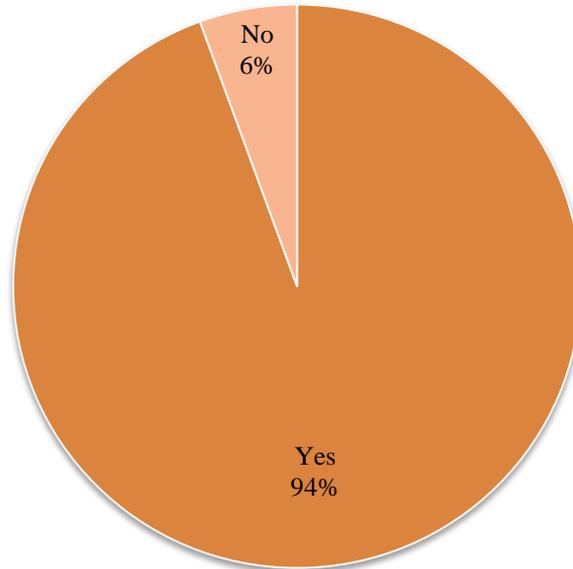
- 11 specific technologies entered in the field of “others” are classified by the sub category of D-4) for tabulation. The number of technologies per field and the ratio of the number of entries for each company are graphically summarized.
- Out of 36 companies conducting R&D, 11 companies reported major R&D results in the field of “others,” which is 31% of all respondent companies. Each of those companies has one result.
- The sub category of “others” includes technologies that seem to belong to sub categories “waste disposal/treatment or recycling” or “soil remediation or water purification,” which belong to the field of “global environment,” or “electromagnetic waves or radiation” in the field of “comfort and health.”

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D-8) Cooperation with universities or companies such as joint research or contract research

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a) Joint research or contract research



Cooperation with universities or companies

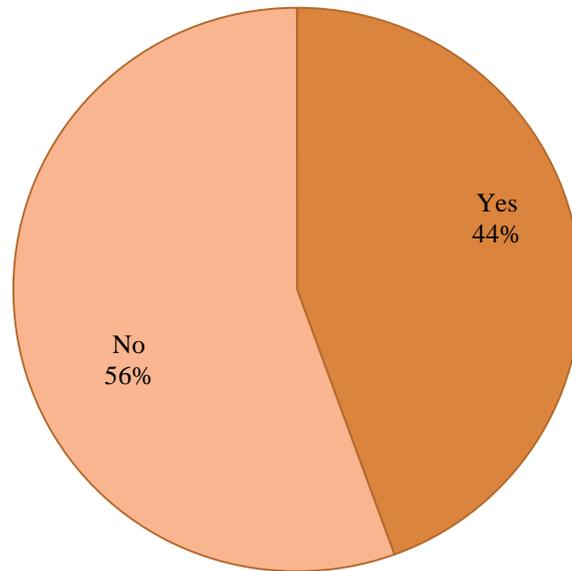
(No. of respondents: 36)

- 
- The answers to the question of cooperation with universities or companies given by 36 companies conducting R&D are graphically presented.
  - Out of 36 companies conducting R&D, 34 companies (94.4%) have cooperation with universities or companies by means of joint research or contract research.
-

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D-9) Type of cooperation with universities or companies

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Contract research with universities or companies

(No. of respondents: 36)

- 
- 36 companies conducting R&D, out of a total of 40 companies who answered this question, were asked if they conduct research under a contract with universities or companies.
  - 16 companies conduct contract research with universities or companies (44%), which is about half of the companies conducting joint research.
-

## 5. Summary

### A. Basic Corporate Information

Member companies were asked about their basic corporate information in the questionnaire survey. 40 companies returned their answers. Out of them, 36 companies, or 90%, say they conduct R&D. Based on this result, the analysis has been conducted for those 36 companies conducting R&D as described in the following section B.

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[Analysis by the item]

#### 1) No. of employees

- The range from 500 to less than 1,000 accounts for 30% (12 companies), the largest number, followed by the range from 2,000 to less than 5,000 for 23% (9), the range from 1,000 to less than 2,000 for 20% (8), and the range of less than 500 for 15% (6).

#### 2) Sales volume

- The range from ¥20 billion to less than ¥50 billion accounts for 22% (9 companies), followed by the range from ¥50 billion to ¥100 billion for 25% (10), the range from ¥100 billion to less than ¥500 billion for 40% (16), the range from ¥500 billion to less than ¥1 trillion for 5% (2), and the range from ¥1 trillion to less than ¥2 trillion for 8% (3).

#### 3) Implementation of R&D

- 85% or 32 companies conduct in-house R&D. 5% or 2 do not conduct R&D by themselves but subcontract or commission R&D. 10% or 4 conduct no R&D.
- 

### B. Organizational System for R&D

Out of companies conducting R&D, about 80% of them have "dedicated division for planning and management," "dedicated R&D division with experiment facility," and "division responsible for intellectual property management," respectively. As many as 10 companies, 25%, have both divisions with experiment facilities and divisions without experiment facilities.

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[Analysis by the item]

#### 1) Dedicated division that conducts planning/management of R&D

- Out of 36 companies conducting R&D, 32 or 89% say they have a dedicated division for planning and management of R&D.

#### 2) Dedicated R&D division with their own experiment facility

- Out of 36 companies conducting in-house R&D, 28 or 78% have a dedicated R&D division with their own experiment facility.
- When R&D divisions with experiment facilities are analyzed in terms of the number of themes and R&D expense, companies have those divisions when the number of themes exceeds 10, and the lower limit for companies with experiment facility is about ¥20 million, while the upper for the companies with no experiment facility limit is about ¥120 million.

#### 3) Dedicated R&D division without their own experiment facility

- Out of 36 companies conducting R&D, 16 companies or 44% say they have a dedicated R&D division without their own experiment facility.

#### 4) Division responsible for intellectual property management

- Out of 36 companies conducting in-house R&D, 31 companies or 86% have a division responsible for intellectual property management. There is no specific correlation found among the presence of IP management division, the number of themes, and R&D expense.

## 5) No. of researchers

\*Researchers as defined here include not only those dedicated to research in laboratories or research divisions but also those who spend the majority of their service time on R&D. This definition is almost the same as that of "those mainly engaged in research" used in the questionnaire of the Ministry of Internal Affairs and Communications or that of "the number of researchers" used in Nikkei Questionnaire.

- The largest number of researchers employed is 297, while the smallest is 2. The average is 48.
- The largest number of companies, or 20, belongs to the bracket of 10 to less than 50 researchers, occupying the majority of the companies, or about 56%.
- For the ratio of the number of researchers to that of all employees, the majority of the companies, or about 50%, belong to the range from 1 to less than 2%.

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## C. R&D Expense

About 70% of the companies spend over ¥100 million on R&D, while about 25% spend over ¥1 billion. The ratio of the total R&D expense to the total sales volumes is 0.56% for the respondent companies. For the ratio of R&D expense to that of the previous year, 66% of the companies reduced it. Of them, 44% reported a decreased ratio in the range from over 80% to less than 100%. This means the reduction ratio itself is not so large.

For the average of R&D expense proportion by the genre and length of themes, 10% for fundamental research, 30% for applied research, and 60% for development, and 71% for short-term themes (less than two years) and 29% for medium- and long-term themes. For the theme proportion of building, civil engineering and joint, it is 56.9%, 34.1% and 9.0%, respectively.

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### [Analysis by the item]

#### 1) Expense incurred for the entire company (expense publicly announced)

- Zero yen accounts for 3% (one company), less than ¥100 million for 25% (9 companies), the range from ¥100 million to less than ¥200 million for 17% (6), the range from ¥200 million to less than ¥500 million for 8% (3), the range from ¥500 million to less than ¥1 billion for 17% (6), the range from ¥1 billion to ¥2 billion for 14% (5), and over ¥2 billion for 14% (5). 3% or one company disclosed no information on this.

#### 2) Ratio of 1) to the sales volume

- The data of 35 companies excluding four companies conducting no R&D and one company disclosing no information are graphically summarized.
- Of 35 companies, the highest ratio is 0.3 to less than 0.4%, accounting for 8 companies.
- 25 companies are in the range from 0 to less than 0.4%, or 71% of all the companies.
- For a company with the highest ratio of R&D to the sales volume, the ratio is 0.92%.
- The average (total R&D expense / total sales volume) for 35 companies is 0.56%.

#### 3) Ratio of 1) to the previous year's expense

- The average ratio of R&D expense for 32 companies to that of the previous year is 97%, with the highest being 198% and the lowest 69%.
- The majority of companies belongs to the range of 80% or more to below 100% for the ratio of R&D expense to the previous year, which is 44%. This is followed by the range from 100% or more to below 120%, accounting for 28%, the range from 60% or more to below 80% for 22% of the companies, the range from 120% or more to below 140% for 3%, and the range from 180% or more to below 200% for 3%.
- 22% of the companies stated an increase in R&D expense from the previous year, 13% have no change, and 66% recorded a decrease.

#### 4) Proportion of fundamental research, applied research and development

- The average R&D expense proportion by the genre is 10% for fundamental research, 30% for applied research and 60% for development.

- 5) Percentages of short-term themes (less than 2 years) and medium- and long-term themes
  - For the R&D expense proportion by the length of theme, 71% of 34 companies spend money on short-term themes, while 29% on medium- and long-term themes.
  - Classifying the short-term theme ratio by every 10%, the largest number of companies are in the range from 80% or over to below 90%, followed by those in the range of over 90%, as shown in the above figure.
  - Companies whose ratio of medium- and long-term themes is over 50% occupy 15% of all respondent companies.
- 6) Percentages among building themes, civil engineering themes and joint themes
  - The thematic proportion of R&D expense is 56.9% for building themes, 34.1% for civil engineering themes, and 9.0% for joint themes.
  - The ratio of R&D expense between building themes and civil engineering themes greatly vary depending on the companies.

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#### D. R&D Themes

Ongoing R&D themes are "quality and productivity improvement" addressed by 36% of the companies, "safety and security" by 24%, "global environment" by 22%, "comfort and health" by 6%, and "others" by 12%.

Popular themes of particular interest include "anti-earthquake measures (aboveground)" in "safety and security" pursued by 23 companies, "concrete" in "quality and productivity improvement" by 23, and "energy saving and CO2 reduction" in "global environment" by 18. For "nuclear decontamination," it was not categorized into either the major category or sub category when this questionnaire was developed, and was therefore categorized in various fields at the discretion of each company.

Out of 36 companies conducting R&D, 34 companies (94.4%) have cooperation with universities or companies by means of joint research or contract research according to the answers of the respondents.

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#### [Analysis by the item]

##### 1) Total number of R&D themes

- 47% or 17 companies pursue 20 themes or less, 19% or 7 companies pursue R&D on 21 to 40 themes, 6% or 2 pursue 41 to 60 themes, 11% or 4 pursue 61 to 80 themes, and 17% or 6 pursue 100 themes or more.
- For the number of development themes per researcher, 1.4 is the average for 36 companies. There is no difference between the major five and the rest of the companies.
- The R&D expense per theme is ¥15 million on average for 36 companies. There is a large difference between the major five and the rest of the companies, with the former being about ¥29 million on average and the latter about ¥13 million on average.

##### 2) Percentage of R&D themes by the field

- When a total of 2,269 R&D themes pursued by 36 companies are classified by the technical field, the proportion is 36% for quality and productivity improvement, 24% for safety and security, 22% for global environment, 6% for comfort and health, and 12% for others.
- Although shown above is the overall theme balance, when there is a company whose proportion of themes for a specific field is greater than others, it means this company puts a particular premium on that field. There are 17 out of 36 companies that have themes of a specific field exceeding 50% of all themes. Those companies are composed of 12 prioritizing quality and productivity improvement, 3 prioritizing global environment, and 3 prioritizing safety and security.

##### 3) Percentage of R&D theme expense by the field

- The data of 33 R&D conducting companies that answered the ratios of R&D spending by the field are summated by the field, and the ratio of all R&D expenses of the 33 companies by the field is analyzed.
- R&D spending on quality and productivity improvement accounts for the largest percentage, or 45%, followed by the spending on safety and security for 22% and global environment for 21%.

#### 4) Field of particular interest

##### a) Global environment

- For the field of global environment, the largest number of companies, or 18, cited as fields of particular interest "energy saving or CO2 reduction," followed by 12 citing "soil remediation and water purification," 7 each citing "new energy" and "waste disposal/treatment and recycling," and 3 citing "ecosystem preservation." One company gave "nuclear decontamination" as a focal field in the field of "others."

##### b) Safety and security

- For the field of safety and security, themes of particular interest in the descending order are: anti-earthquake measures (aboveground) addressed by 23 companies, anti-earthquake measures (underground) by 12, anti-earthquake measures (nonstructural members) by 3, and anti-tsunami measures by 3. These totally account for 91% (41 companies). Other than the above, two gave "BCP and risk assessment," and another two gave "structural analysis" as their focal fields.

##### c) Quality and productivity improvement

- In the field of quality and productivity improvement, the largest number of companies or 23, cited as their focal field "concrete," followed by seven companies citing "robot and automated construction" and "maintenance" and six citing "aboveground structural method." For the field of "others", "tile application method" is given by one company.

##### d) Comfort and health

- In the field of comfort and health, the largest number of companies or 11, cited as their focal field "sound and vibration environment," followed by two citing "temperature, humidity, and light environment" and one citing "air environment" and "electromagnetic waves and radiation" each.

##### e) Others

- In the field of "others," there are three companies focusing on engineering technology, and two on BIM-related technology.

#### 5) R&D themes on restoration from earthquake disaster

- Among 36 companies conducting in-house R&D, 31 conduct R&D on restoration from earthquake disaster.
- The majority of companies conduct R&D on restoration from earthquake disaster. Answers on the major R&D results in the past one year as in D-7) used such keywords as decontamination technology, seismic retrofit, base isolation, anti-liquefaction measures, and anti-tsunami measures in their major R&D results.

#### 6) No. of information releases issued by the field in the past one year

\*"Releases" used here include the information disclosed to the public such as news releases published in the official websites or delivered to newspapers.

- The total number of releases is 753.
- For the releases by the field, the most frequently covered field is c) quality and productivity improvement, which is cited in 222 releases. The second most popular is b) safety and security cited in 181, followed by a) global environment by 168, and d) comfort and health in 45. This result is understood to be the reflection of the interests of customers or society.

#### 7) Major R&D results in the past one year

##### a) Global environment

- 29 companies answered the question on the field of global environment, and the total number of R&D results is 53.
- In the field of global environment, the largest number of companies, or 14, delivered the R&D results in "soil remediation and water purification." followed by 13 companies delivered results in "energy saving or CO2 reduction", 10 in "others," 9 in "waste disposal/treatment and recycling," 3 in "ecosystem preservation," and 2 in "new energy" and "greening and heat island effect prevention," respectively.

##### b) Safety and security

- 29 companies answered this question in total. One of them provided three or more results. All entries in R&D results are therefore counted. The total number of entries is 55.
- In sub sub categories, the largest number of entries, or 20, are made in "anti-earthquake measures (aboveground)" (37%). Companies engaged in technical development in the field of "safety and security" account for 81% of all respondent companies.

##### c) Quality and productivity improvement

- There are 63 entries in total. The largest number of entries, or 20, was made in "concrete." It is followed by "aboveground structural method" in which 13 results were entered, and underground structural method with 8

entries.

- Out of 36 companies conducting R&D, as many as 33 companies (92%) entered their major R&D results in "quality and productivity improvement" (including 72% for two or more entries and 19% for one entry). It indicates that many companies are trying hard to tackle R&D on "quality and productivity improvement," the essence of manufacturing.

d) Comfort and health

- There are 30 entries in total. The most popular category is noise and vibration environment with 13 entries of R&D results. Seven entries are made in other areas. This indicates a wide variety of research and development is conducted.
- Out of 36 companies conducting R&D, 19 entered their major R&D results in the field of "comfort and health," which is 53% (including 22% for one entry and 31% for two entries). Nearly half of all the companies, or 47%, provided no result.

e) Others

- 11 companies entered their major R&D results in the field of "others," which is 31% of all respondent companies. Each of those companies has one result.
- The sub category of "others" includes technologies that seem to belong to sub categories "waste disposal/treatment and recycling" or "soil remediation and water purification" belonging to the field of "global environment," and to "electromagnetic waves and radiation" in the field of "comfort and health."

8) Cooperation with universities or companies such as joint research or contract research

- Out of 36 companies conducting R&D, 34 companies (94.4%) have cooperation with universities or companies by means of joint research or contract research.

9) If your answer is yes for 8), describe the type of cooperation.

- 16 companies or 44% out of 34 companies conduct contract research with universities or companies, which is about half of the companies conducting joint research.

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## Conclusion

This survey was conducted for the purpose of “promoting society's understanding of the construction industry,” one of the priorities of JFCC. It aims to obtain the basic data necessary to put up proposals or formulate plans for achievement of the said purpose by understanding the status of R&D activities in the construction industry, such as clarifying how each company conducts R&D with how much budget and how many staff and on what themes, and to make the R&D activities of the construction industry widely known by disclosing the results to the general public, thereby ultimately improving the impression of the construction industry.

The survey revealed the valuable information on R&D of the member companies, including the scale of R&D activity, the way they conduct R&D, or their fields of particular interest. The survey results are summarized in this report. We intend to disclose the results widely to the general public through the website of JFCC and news releases.

This kind of comprehensive survey was conducted for the first time this year, and we intend to continue this survey every year. We, however, realize it necessary to appropriately change the contents by incorporating changes in items with time into the next version or adding new survey items considered necessary for any given year. We also intend to revise and improve the questionnaire procedure by modifying, for example, questions difficult to answer because of inappropriate explanations.

Last but not least, we sincerely acknowledge the member companies of the Building Division for their cooperation with the survey.



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in the Construction Industry

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