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Urban Renewal and Resource Recycling: For the Creation of a Resource Recycling Society

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Contents

Urban Renewal and Resource Recycling: For the Creation of a Resource Recycling Society

Summary

1. Construction stock in Japan has continued to increase more or less consistently since the war. Compared to FY1960, the total floor space of buildings multiplied nearly 4-fold to 7.4 billion square metres in FY2000 and the value of social infrastructure stock nearly 14-fold to 617 trillion yen in FY1993, at 1990 prices. There are fears that the output of construction waste accompanying the renewal of this stock will increase in future. The actual degree of stock demolition is influenced by trends in new construction investment. However, assuming a constant probability of stock obsolescence with age, we may expect marked increases in output over the next ten years. These will mainly involve non-timber buildings, which increased greatly in the 1970's, and social infrastructure in the public engineering sector.

2. Taking the example of buildings, if we assume the average life of timber buildings to be 33 years, that of non-timber buildings to be 40 years, and that of civil engineering structures to be their corresponding service life, we may calculate that the total output of construction waste (excluding waste construction soil) would increase 2-fold to 313 million tons in FY2010 and 2.7-fold to 415 million tons in FY2030, compared to the figures for FY2000. In particular, in the period from FY2000 to FY2010, when buildings constructed in the 1970's reach the renewal phase, a high average increase rate of 7.5% p.a. is forecast. Meanwhile, if we estimate the volume of waste construction soil arising from construction on a civil engineering works basis, we obtain increases of about 1.6-fold in FY2010 and about 2-fold in FY2030 compared to FY2000, as with other construction wastes.

3. The output of industrial waste in Japan has been at the level of 400 million tons per year in recent times. The weight of the construction industry within this is around 20%, exceeded only by agriculture and the electricity, gas, heating, and water supply industries. Comparing the state of processing to that of all industrial waste, the recovery rate (mainly involving waste concrete and waste asphalt concrete) is higher, but the weight of final disposal is also much higher than the overall average (all industrial waste 18%, construction waste 42%). Construction waste also accounts for around 70% of cases and 40% of the weight of illegal dumping. Based on this present situation of construction waste and the anticipated increase in future, the Construction Materials Recycling Act was enacted in May 2000. This established a new framework that includes an obligation to sort and recycle dismantled materials in construction work exceeding a certain scale.

4. In the course of improving recycling rates for materials targeted by the Construction Materials Recycling Act (waste concrete, waste asphalt concrete, and waste construction timber), the processing demand that is expected to occur in future (i.e. the difference between the demand if the previous processing level were maintained and that sought by the Act) will reach around 120 million tons by the year 2010, and will continue to increase gradually thereafter. In terms of weight composition, the majority will be taken up by waste concrete, whose output is increasing most markedly. This will be processed on site or in dedicated plants, and recycled into basecourse and other materials. Calculating the market scale for these on the assumption that the recycling cost basis (acceptance) will remain at present levels, the value of newly recycled materials in future would reach around 400-500 billion yen, and the acceptance volume of the construction waste recycling market (excluding waste construction soil), combined with the already existing volume, would be around 800-900 billion yen per year.

5. However, while output grows markedly and the acceptance volume increases, the number of receptors (outlets) for recycled resources is limited. In future, therefore, we will need to expand the uses of recycled resources in order to establish this business as “recycling business” in the true sense. For the time being, the principal problems appear to be (1) waste concrete (recycled aggregate, etc.) that cannot be absorbed by conventional uses such as basecourse materials, and (2) waste construction timber, whose level of processing and recycling needs to be dramatically upgraded under the provisions of the Act. Along with these, technical development aimed at efficient recycling of construction sludge, mixed waste, and others is also expected to progress.

In this sector, the development of new technology for recycling aggregate into mainframe concrete, etc., the development and introduction of on-site recycling machinery, and other business activities aimed at expanding markets are expected to become more lively, especially in the non-ferrous metals and construction machinery industries, and are expected to develop further in future. Meanwhile, there are increasingly lively moves, mainly among the leading general construction companies that issue contracts for work, to support recycling projects in terms of both intake and output. These include the rigorous implementation of sorted dismantling and an expansion of green purchasing aimed at making positive use of recycled resources. These lead to expectations of reciprocal effects. Based on moves such as these, support is surely also needed from the policy side, such as creating a system of quality standards for recycled resources and aiming for positive use in public works. The development of a monitoring system to guarantee this system of quality standards is also to be expected.

6. In preparation for the coming expansion of construction waste accompanying the renewal of buildings and social infrastructure from the era of rapid growth, Japan created a system of construction recycling ahead of other countries. In future, to achieve further progress in technical development aimed at efficient recycling now being positively pursued, backing from government policy to promote the expanded use of recycled materials will surely become even more important. Meanwhile, promoting long service life construction that facilitates sorted dismantling is an important task for the coming decades. In this sector, too, various technical innovations are evident, such as maintenance technology for existing buildings and the development of new materials. These innovations include some from which major effects may be expected across the whole spectrum of the urban environment, such as preventing heat islands and improving scenery, in the case of rooftop garden technology. The development of government policies aimed at diffusing these is also to be expected.

Studies are now underway for a debate on urban renewal. The aim of this is to re-examine Japanese cities from a variety of angles, including amenities and the efficiency of economic activity, in an attempt to upgrade the levels of these. With the renewal phase of large-scale stock nearly upon us, one could hope that this debate will develop in a way that will fully incorporate measures in environmental aspects (such as resource recycling), especially as it represents a timely attempt to define the new image of Japanese cities.

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Introduction

A debate on urban renewal is now underway. Broadly positioned as a measure for maintaining and improving Japan's competitiveness, this is an attempt to revise the conventional image of cities in a variety of ways. For example, strengthening international transport and distribution functions by improving airports, roads, and other infrastructure, developing wide-area disaster prevention systems, achieving symbiosis with the environment, and so on. Upgrading the existing structure of cities through urban renewal could also be seen as a process of reviewing the stock that has been accumulated so industriously until now, and reshaping it into an optimal state. The impact of these efforts will be far-reaching. Of the issues they will affect, this survey takes up that of recycling, and examines the problems of cities from this perspective.

In doing so, the central focus is on concern that the output of construction waste will increase at an unprecedented pace, given that the construction stock that was so rapidly accumulated during the era of high economic growth is now reaching the renewal phase. In Japan, legislation in this sector (the Construction Materials Recycling Act) was enacted earlier than in other countries, and a policy framework to counter this problem is now being created. However, many problems are still thought to remain before the recycling industry sector can efficiently process the burgeoning volume of construction waste within the new framework. In this point lies the main concern of this survey. Besides this, the renewal of construction stock and changes in the use of land accompanying it have the potential to exert a major influence on trends in construction recycling, hand-in-hand with the measures against soil pollution now being debated. Therefore, taking these soil pollution countermeasures as part of the construction recycling sector in the broad sense, this survey will additionally analyze the present situation and study future developments.

In the first section, as a premise to the debate, the future output of construction wastes, expected to increase in line with the renewal of stock, will be calculated with a view to identifying its impact. On the premise of the calculated output, the second section will examine the developments shown by the recycling market in relevant sectors. It will also look at the preparation of other policy systems following the enactment of the Construction Materials Recycling Act, including the technological seeds being presented in these various sectors. Finally, the foregoing discussion will be summarized in connection with the problem of prolonging service life, an issue that affects the generation of by-products.

I Prospects for Recycling Construction Wastes

1. Introduction

A debate on urban renewal is now underway. Broadly positioned as a measure for maintaining and improving Japan's competitiveness, this is an attempt to revise the conventional image of cities in a variety of ways. For example, strengthening international transport and distribution functions by improving airports, roads, and other infrastructure, developing wide-area disaster prevention systems, achieving symbiosis with the environment, and so on. Upgrading the existing structure of cities through urban renewal could also be seen as a process of reviewing the stock that has been accumulated so industriously until now, and reshaping it into an optimal state. The impact of these efforts will be far-reaching. Of the issues they will affect, this survey takes up that of recycling, and examines the problems of cities from this perspective. In this section, we shall examine trends in construction waste generated by the renewal of construction stock.

2. Trends in Japan's Construction Stock

Construction stock in Japan has continued to increase more or less consistently since the war. Figure 1-1 shows trends in construction stock (total floor space), revealing that the total stock area has multiplied nearly 4-fold to 7.4 billion square metres in FY2000 over the last 40 years. As to the rate of increase, timber buildings have been increasing fairly steadily, while non-timber buildings suddenly accumulated in the era of rapid economic growth, thereafter stabilizing at steady growth of a few percent. Fig. 1-2 shows the construction start floor space (flow) per fiscal year. Here, too, non-timber buildings increased at a high level until the first half of the 1970's, with another temporary rise from the end of the 1980's to the beginning of the 1990's.

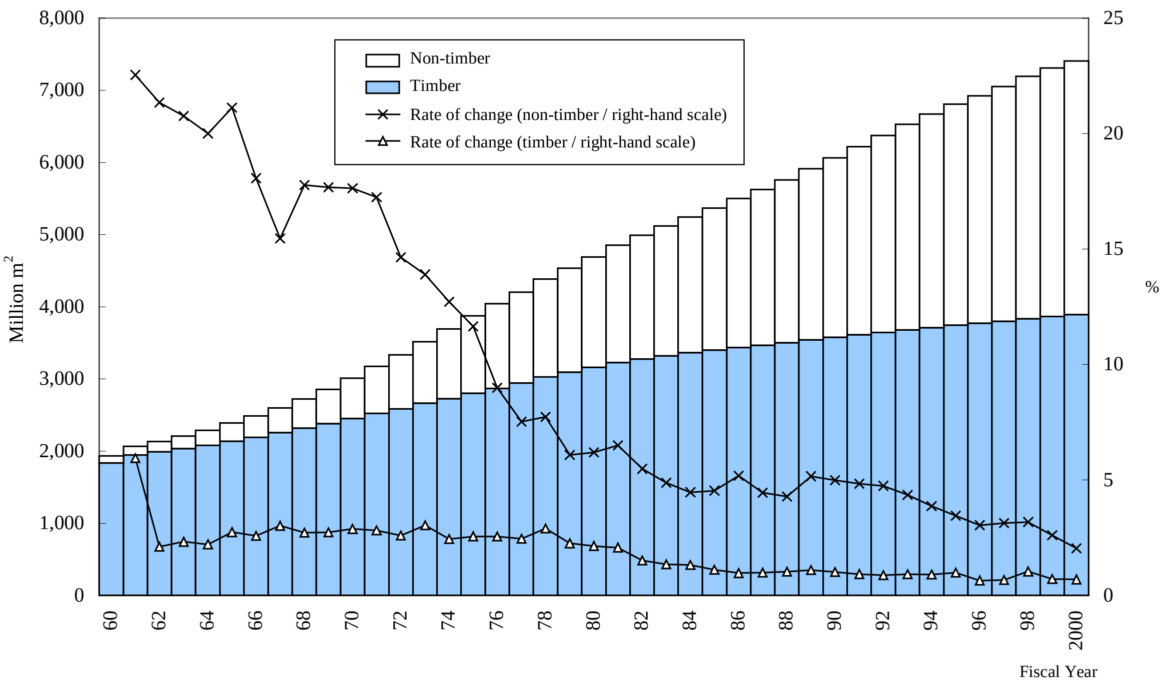


Fig. 1-1 Trends in Construction Stock Area

Source: Ministry of Public Management, Home Affairs, Posts and Telecommunications (Ministry of Home Affairs), "Outline Record of Fixed Asset Prices, etc. (Land, Houses, and Depreciable Assets)"

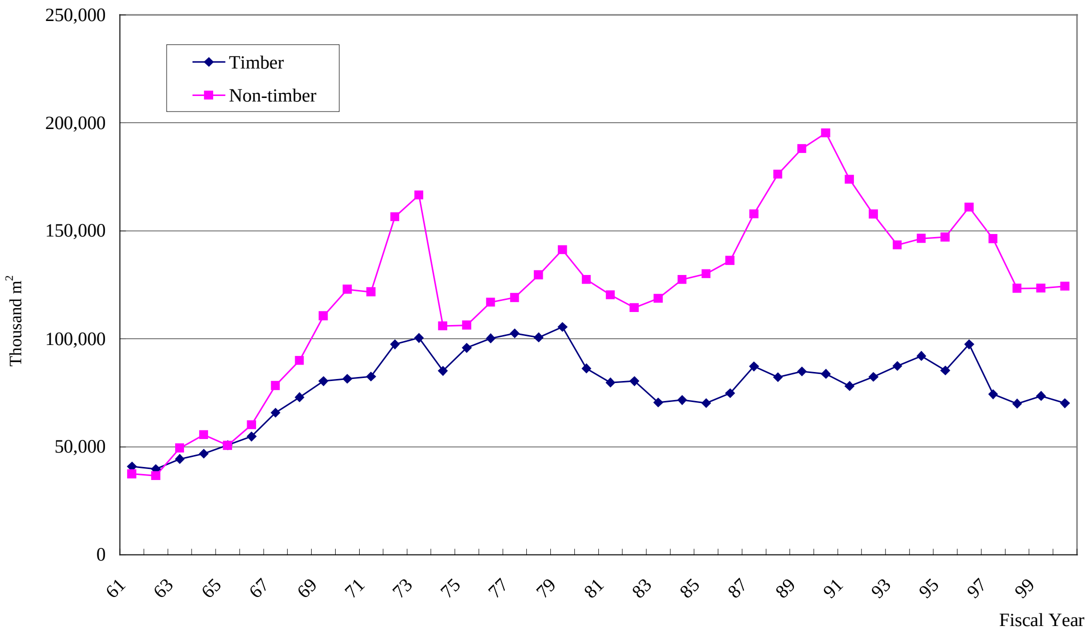


Fig. 1-2 Trends in Construction Start Floor Space

Source: Construction Statistics Annual Report

Turning now to social infrastructure, Fig. 1-3 shows the total value of social infrastructure stock in Japan as estimated by the Cabinet Office (Economic Planning Agency) at 1990 prices. It reveals that the stock multiplied nearly 14-fold over the space of 40 years to 617 trillion yen in FY1993, showing that the development of infrastructure advanced steadily over that period. As with construction stock, the rate of increase expanded significantly until the first half of the 1970's, but then gradually slowed down, except in special cases related to the privatization of the national railways. Fig. 1-4 shows these trends in terms of the public works completion turnover (flow) for each fiscal year.

Both construction and social infrastructure stock accumulated dramatically in the era of rapid growth up to the first half of the 1970's. But now, some 30 years since then, this stock is reaching its renewal phase. As a result, it is feared that the output of construction waste will increase at a pace not experienced before. Here, construction waste refer to materials produced secondarily in the process of construction works (see Fig. 1-5). This is a broad concept that includes recyclable materials, as well as mere waste.

In the first place, the actual degree to which stock demolition occurs is affected by trends in new construction investment. As such, the renewal of buildings and structures tends to arise not so much because they have reached the end of their physical life as structures but rather due to other factors, such as obsolescence in terms of functions. In view of this, there are limits to judgements that focus only on years of service. Nevertheless, with the dramatic upgrading and spread of information technology recently, functional obsolescence is progressing in buildings (for example, insufficient floor height), while urban renewal projects leading to stock renewal are starting in earnest. Considering these factors, it is highly probable that large volumes of construction wastes will be generated intensively over a short period in future. What, then, will be the impact of construction wastes generated from construction stock?

3. Calculation Conditions

When considering trends in construction wastes, the first point to be decided is whether to focus on the generated volume or the output volume. By "generated volume", we refer to the total volume of material from demolished buildings

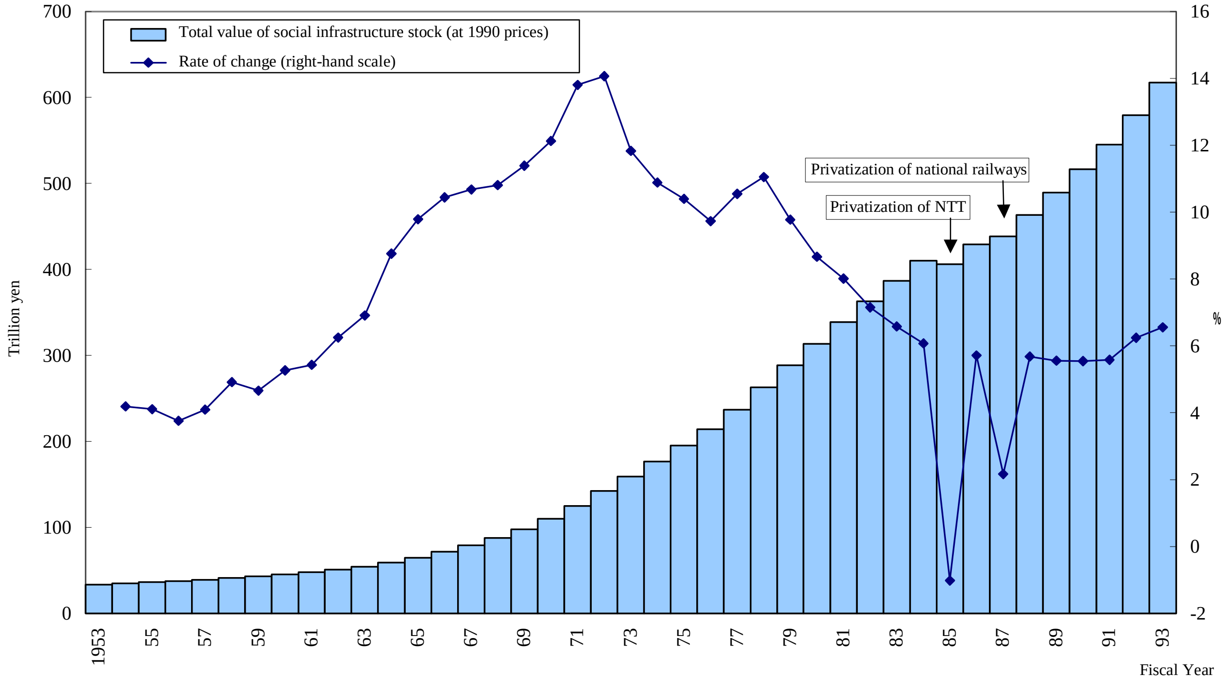


Fig. 1-3 Trends in Total Value of Social Infrastructure Stock (at 1990 prices)

Source: Economic Planning Agency (now the Cabinet Office), “Social Infrastructure of Japan”

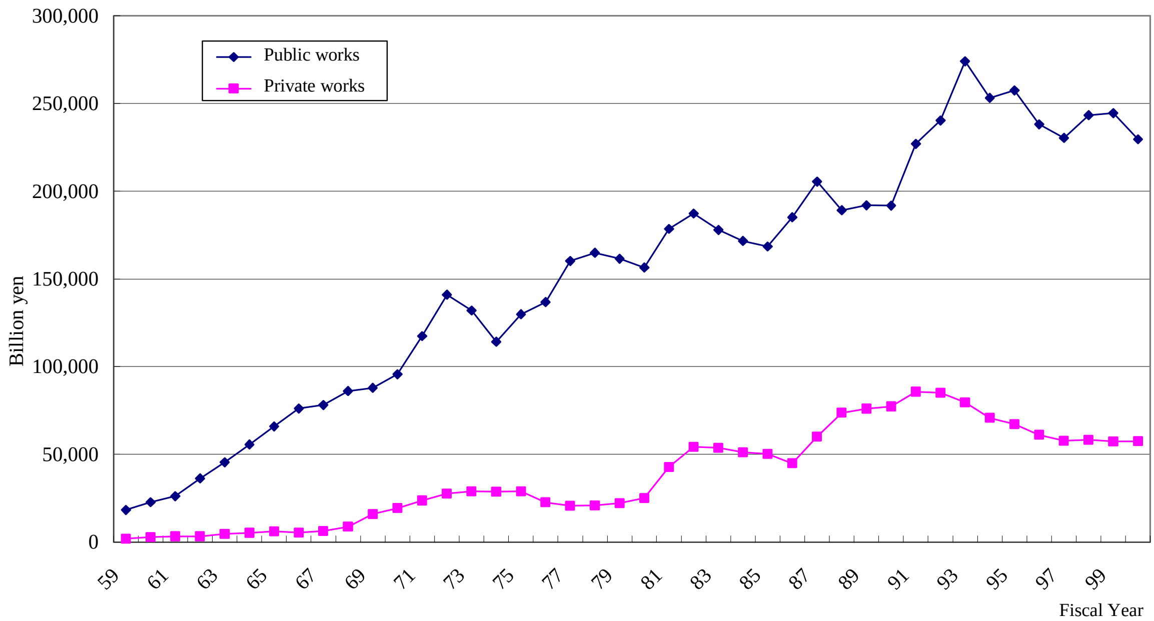


Fig. 1-4 Trends in Value of Civil Engineering Works (at 1990 prices)

Source: Figures for FY1970-2000 are based on Overall Construction Statistics Annual Reports. Those up to 1969 are calculated from data in “Summary of Statistics on Construction Work Orders” (Ministry of Construction) and others. The 61 construction sector deflator in “Social Infrastructure of Japan” (Economic Planning Agency) has been used up to 1993. From 1994, the construction investment

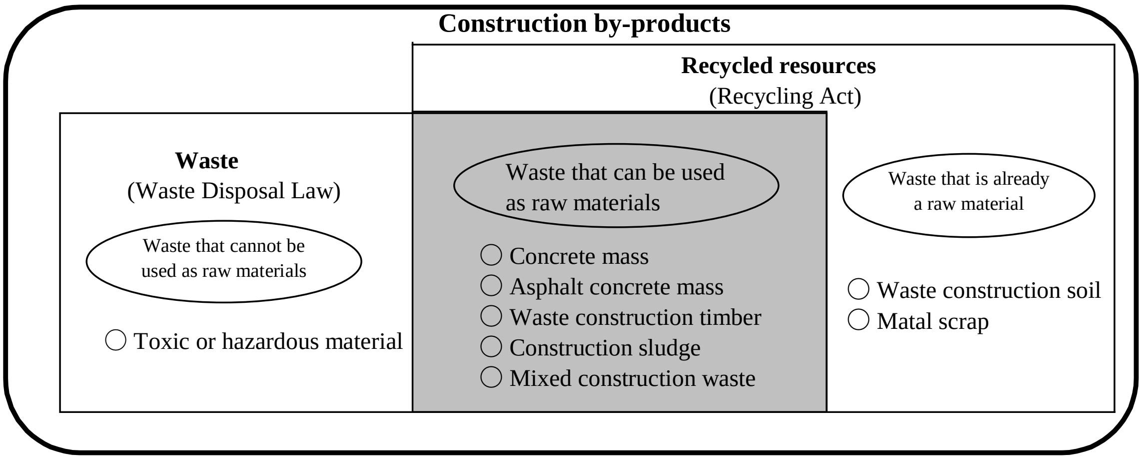


Fig. 1-5 Types of Construction Wastes

Note: Construction wastes are generated both by the demolition of buildings and structures and by new construction work.
Source: Council for PR and Promotion of Construction Waste Recycling, "Comprehensive Measures for Construction Wastes"

and structures, which equals the total volume of construction materials used in them. By contrast, "output volume" is the volume of construction wastes that are not re-used on building sites but are transported outwards. When the parameters (floor space, value) for a given demolished building or structure have been obtained, these are multiplied by a base unit representing the input volume of construction materials [1] (in the case of generated volume), or by a base unit calculated from the transported volume (in the case of output volume). Fig. 1-6 shows the size of the gap between generated volume and output volume by comparing them for buildings (input volume of aggregate and stone, output volume of waste concrete). For input base units, the input volume of aggregate and stone for timber and non-timber structures, respectively, from the Survey on Construction Materials and Labour Demand by the Ministry of Land, Infrastructure and Transport is used for the generated volume. For the output volume, the base unit of waste concrete (approximate to the output volume basis) is used. The latter is also used in the calculations given below. Since the demolition parameters are the same, both show the same tendency. In terms of general levels, generated volume far exceeds output volume.

The cause of the difference between the two is thought to be that some of the waste generated by demolition works are re-used or reduced on site. In fact, the Construction Waste Processing Manual recommends that outsourcing and contracting firms make efforts to recycle and re-use their construction waste, stating at the outset "Waste should be converted to a form that may be sold for value, and should be sold or used by the generator". Here "used by the generator" means that a business that generates construction waste should attempt to use that waste for its own purposes, on condition of suitable quality. This shows that re-use on-site has already been recommended in previous usage.

When calculating the impact of construction wastes recycling, both the generated and output volume are of significance. However, the following discussion will be developed on the basis of output volume, unless otherwise specified. This is in view of the fact that the output basis is used both for "construction material waste" subject to recycling under the Construction Materials Recycling Act (as discussed below) and in the Surveys on Construction Wastes (referred to below as "Census Surveys"). The latter, conducted three times so far, is the only source of data that can be compared with the calculation results.

[1] For pioneering research in relevant sectors using this technique, see Fujii (1993) (References).

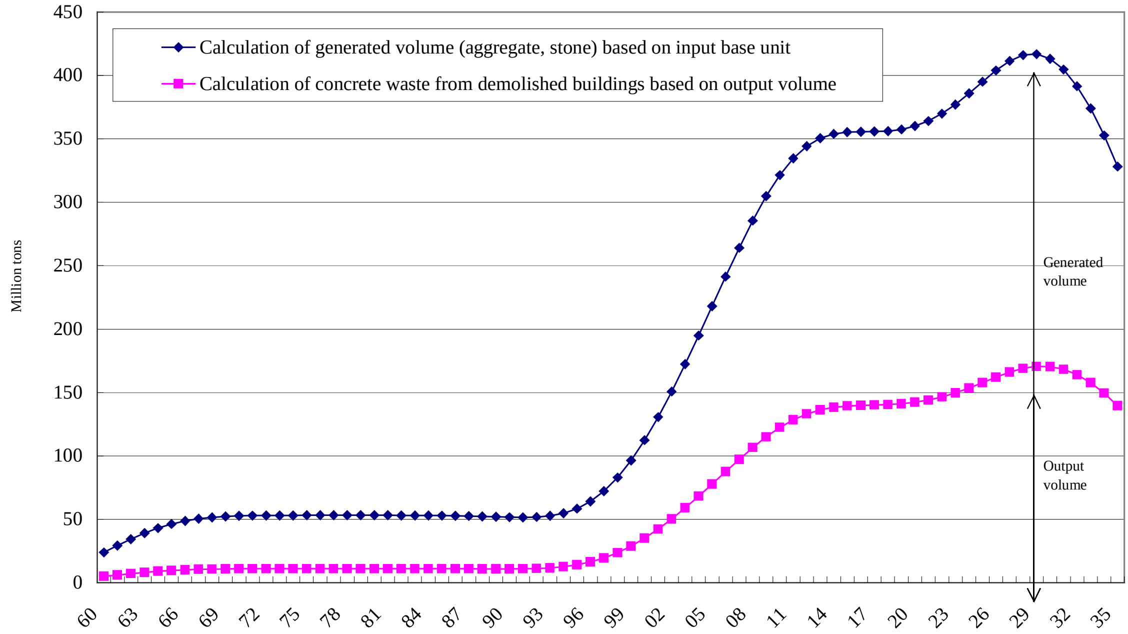


Fig. 1-6 Calculation Conditions (generated volume and output volume)

Source: Calculated by the DBJ from Survey on Construction Wastes, Survey on Construction Materials and Labour Demand, etc.

4. Outline of Calculations

The output volume of construction waste is calculated by multiplying the volume of waste generated from both buildings and civil engineering structures (floor space and value; referred to below as "demolition parameters") by the output volume base unit. The demolition parameters are calculated on the assumption that buildings or civil engineering structures whose construction is started (or completed) in a certain fiscal year will reach the end of their useful life with a certain probability after being used for a fixed period. The probability that they will be demolished (the demolition probability rate) may be projected in a number of ways. Here, however, as a simple technique, we will assume a discrete density coefficient that approximates normal distribution.[2]

4.1 Buildings

For the construction work flow figures in each fiscal year, forming the conditions for calculating the demolition parameters (floor space), we use the construction start floor space for each type of structure (timber, non-timber). The relevant figures are taken from the Construction Statistics Annual Report mentioned in Fig. 1-2 above. This is then extended from the years 2001 to 2035 in line with the Medium to Long-Term Forecast for the Construction Market issued by the Construction Economics Research Institute.

For the demolition probability rate, we assume a service life of 33 years for timber buildings and 40 years for non-timber, assume the above-mentioned density coefficient approximating normal distribution with the respective number of years as the average value, and multiply this by the flow for each year. The demolition parameters are calculated by accumulating the results of this multiplication.

For the base unit, we divide the output of construction wastes into (1) those arising from

[2] We assume a density coefficient that approximates the normal distribution (N(μ, $(3.989)^2$)) (μ = average service life), taking the demolition probability rate after the average service life as 10%. This is the same as the hypothetical demolition probability rate in the Building Demolition Waste Generation Forecasts (Tokyo and 8 prefectures) included in the Demolition and Recycling System Research Group Report in October 1998.

the demolition of buildings (the demolition type) and (2) processing waste discharged in conjunction with building work (the new construction type). We multiply the former by the existing output base unit for each type of structure, and the latter by a base unit calculated from the FY1995 Census Survey, without differentiating between different structures. The base unit changes with the passage of time, due to changes in construction methods, building materials, etc. However, in these calculations it will be kept constant due to constraints on data availability.

Figure 1-7 shows the output volume obtained from buildings as calculated in this way. It indicates that, since the non-timber buildings that were greatly accumulated in the era of rapid growth are reaching the renewal phase, the output volume from construction works will increase over the next 10 years or so. The circles in the diagram show the results of the three Census Surveys held over this period.

According to this calculation, the output volume of construction waste arising from demolished buildings will increase dramatically after FY2000, multiplying more than 4-fold in FY2010 compared to FY1995. Fig. 1-8 shows the breakdown for different materials, revealing that, as the demolition of non-timber buildings advances, waste concrete accounts for the majority of the materials involved, and, moreover, accounts for the larger part of the increase.

4.2 Civil Engineering

Next, the annual flow for civil engineering works uses the figures for public and private engineering (completed work basis) for each fiscal year from the Overall Construction Statistics Annual Reports mentioned in Fig. 1-4. After converting these to real figures (at 1990 prices) using the 61 construction sector deflator issued by the Cabinet Office (Economic Planning Agency) and augmenting past data omissions as appropriate, a base sequence is prepared for each length of service life. For FY1994 onwards, when the deflator is no longer usable, the construction works deflator (1995 prices) is converted and linked to an EPA basis for conversion to real figures. From FY2001 on, meanwhile, both public and private civil engineering works remain on a par at FY2000 amounts.

For the demolition probability rate, we assume that the statutory service life for each construction work is the average service life, and assume a density coefficient in which 10% of all structures are demolished after the average service life, as in the case of buildings.

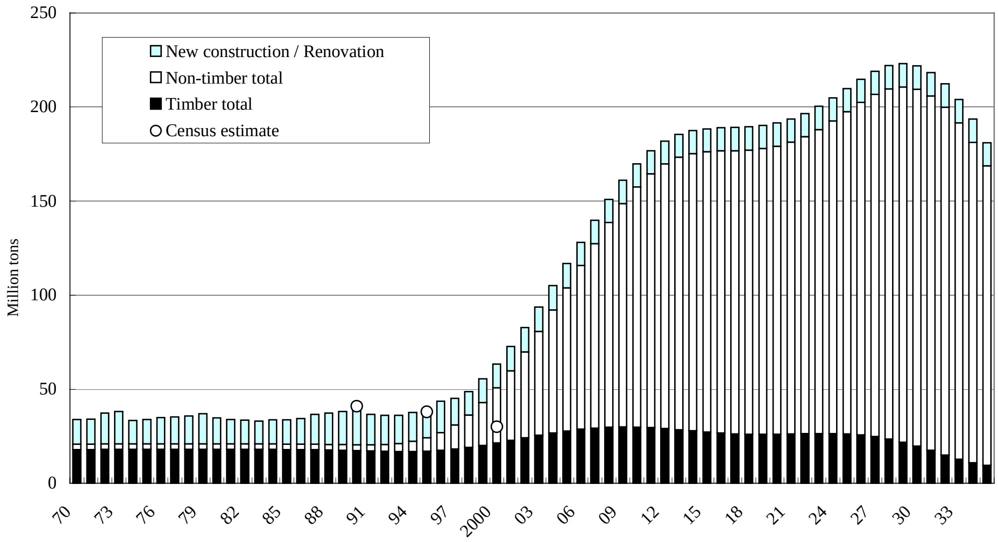


Fig. 1-7 Output of Construction Wastes Arising from Buildings

Note: For the construction start floor space from FY2001, we adopt the No. 1 scenario given in the Long-Term Forecast for the Construction Market by the Construction Economics Research Institute (real GDP growth rate: 01-10 2.0%, 11-20 2.5%), staying on a par from 2020 (until 2035).

Source: Calculated by the DBJ from Construction Statistics Annual Reports, Outline Records of Fixed Asset Prices, etc., Surveys on Construction Wastes, Medium to Long-Term Forecasts for the Construction Market, etc.

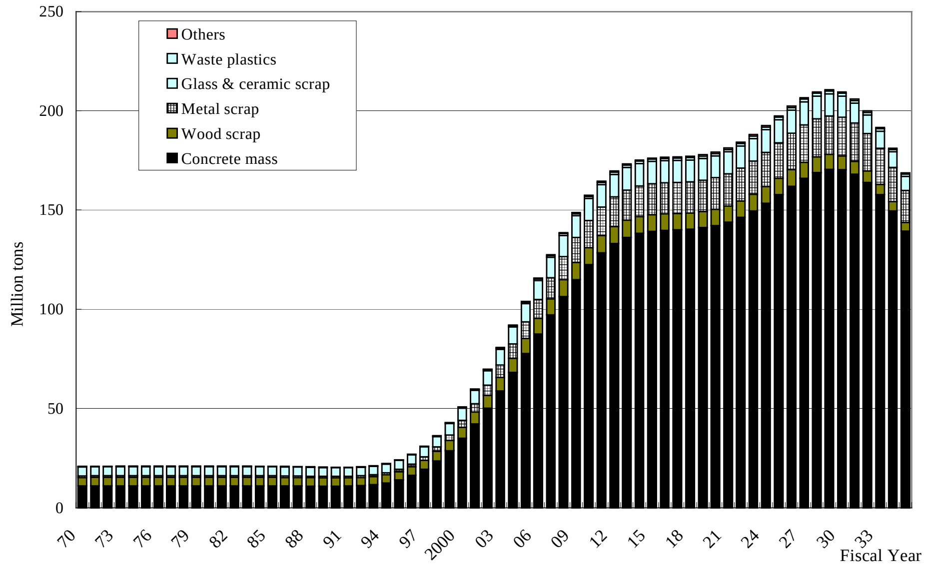


Fig. 1-8 Calculated Output of Construction Wastes from Demolition
(by the type of waste)

Source: See Fig. 1-7

There are several previously calculated data that could be used as the base unit to be multiplied by the demolition parameters (value) thus calculated. But all of these are problematic in that they are not consistent with the demolition parameters calculated as above. Thus, in this survey, we have prepared base units for waste concrete, waste asphalt concrete, waste timber, construction sludge, and waste construction soil from the demolition parameters and the FY1995 Census Survey for use in these calculations.[3]

Figure 1-9 shows the results thus obtained (excluding waste construction soil). The circles in the diagram show the results of Census Surveys, as in the case of buildings. According to this calculation, the output volume from civil engineering works will also grow to more than double the FY1995 level in FY2010. Moreover, as in the case of construction works, it is expected to increase vastly over the next 10 years or so. Judging by the breakdown given in Fig. 1-10, the majority of this will take the form of waste asphalt concrete, waste concrete, and construction sludge.

4.3 Relationship with Census Surveys

The foregoing offers a scenario whereby the stock accumulated throughout the era of rapid growth is demolished over a short time, and construction waste increases dramatically as a result. In the following, various discussions will be pursued on this basis. But before doing so, the relationship between this scenario and the Census Surveys should be defined.

Three Census Surveys have been conducted so far. As can be seen from the diagrams above, the results of the FY1990 and FY1995 surveys do not look out of place when superimposed on the rapid increase scenario. However, the result of the third survey in FY2000 shows a level that is significantly at variance with the scenario. Specifically, the output of construction wastes (excluding waste construction soil) in FY2000 was 85 million tons, showing a decline of around 15% compared to the 99 million tons in FY1995. This runs counter to the trend of the increasing scenario. How should we interpret this discrepancy?

[3] The base unit for output from civil engineering works differs greatly depending on whether calculated as a “transported volume base unit” in the 1990 Census Survey, for example, or whether calculated from simple aggregated data for the second half of FY1998 as a simplified census. Therefore, as indicated above, we have prepared the base unit by combining the demolition parameters created as a condition for this calculation with the 1995 Census. It should be noted that this figure has no independent significance outside the scope of this survey.

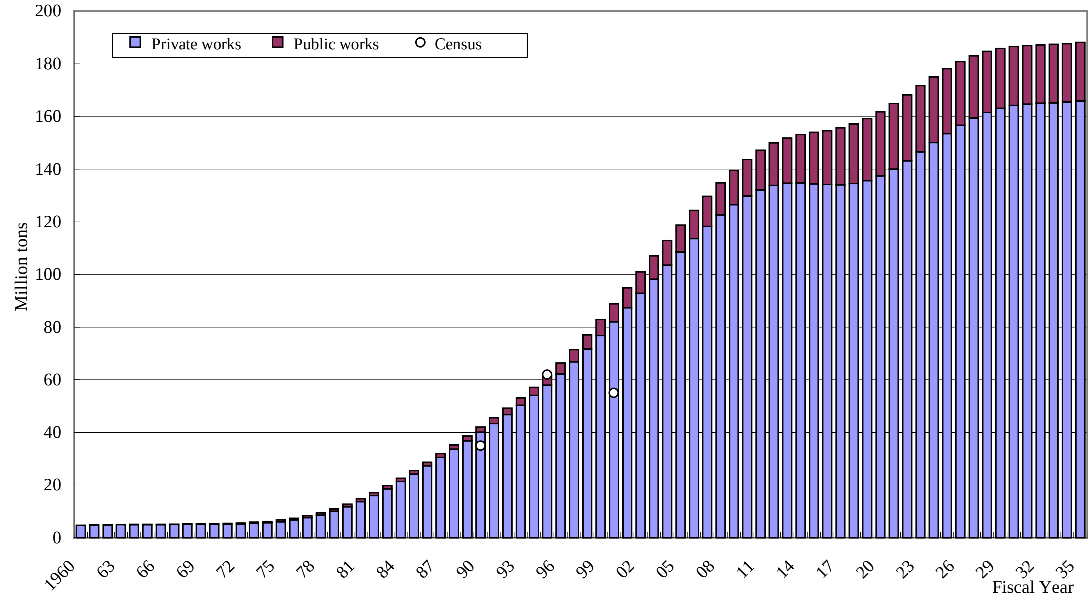


Fig. 1-9 Calculated Output of Construction Wastes from Civil Engineering Works

Source: DBJ calculations

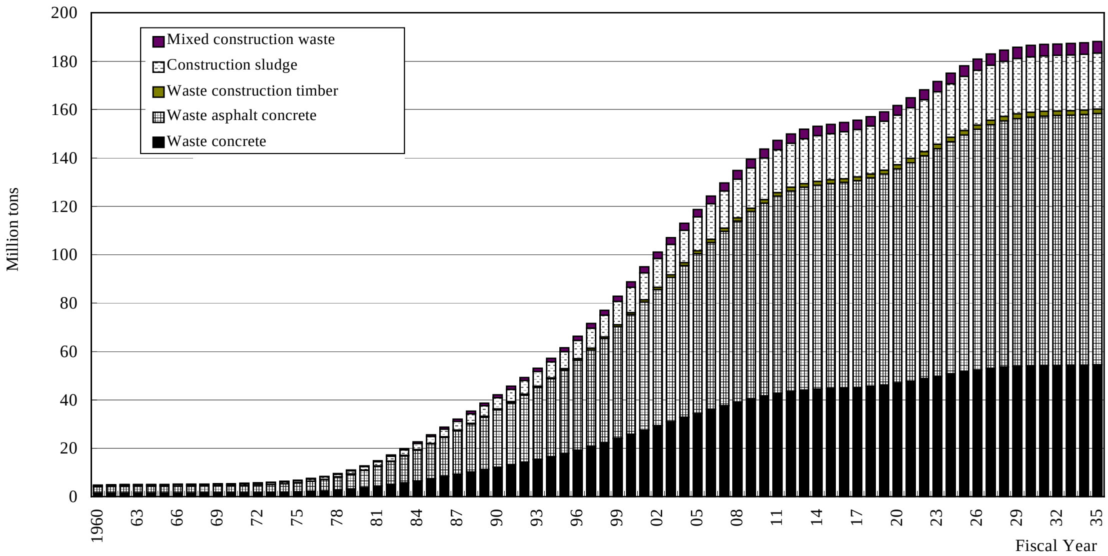


Fig. 1-10 Calculated Output of Construction Wastes from Civil Engineering Works
(by type of waste)

Source: DBJ calculations

The cause of the reduced output is thought, among others, to be that re-use on site has progressed (or, in other words, that the output base unit has decreased). In the Census Surveys, however, it is mainly attributed to a decline in construction starts and public works. The Census Surveys emphasize factors whereby the demolition of stock is affected by the level of new construction investment (i.e. demolition is implemented because of new construction works), and estimate the whole output for single fiscal years based on new construction investment. If we adopt this approach, the volume of demolition will also decrease, reflecting the fall in immediate construction investments. By contrast, the rapid increase scenario mentioned above takes an approach that focusses on developments over a period of time, namely how the total volume of construction stock will be discharged in future as wastes. Its rationale is that the demolition of buildings and structures occurs at a fixed rate of probability with the lapse of time, regardless of whether or not is accompanied by new construction. Therefore, the impact of immediate increases or decreases in construction investment is small. The Census Surveys could be seen as following a technique suited to surveys of output in single fiscal years, while the output rapid increase scenario adopts an approach that is suited to examining the long-term development of construction wastes. It should therefore be borne in mind that the two methods basically differ in nature.

Here, for reference, let us incorporate the gist of the Census Surveys in the rapid increase scenario. Fig. 1-11 compares the construction start floor space and civil engineering turnover used in the above calculation with the demolition parameters for each, deduced from the demolition probability rate. In either case, while new construction works gradually turned to a decrease from the middle of the 1990's, the demolition parameters continued to increase, showing a lack of uniformity in the behaviour of the two. If we consider demolition as accompanying new construction works, the demolition parameters would also have to decrease from the mid-1990's onwards. So, next, we will change the demolition parameters by the rate of increase or decrease in new works (without altering the other conditions). Figs. 1-12 and 1-13 show what happens when this is applied to buildings and civil engineering works, respectively. Since the demolition parameters will also be calculated using the rate of change in new works from fiscal 2000 onwards, the output of construction waste should remain virtually unchanged, given that new works are unlikely to increase greatly under present circumstances. While this "no change scenario" would increase in conformity with the fiscal 2000 Census Survey, factors of temporal variation in the accumulation of stock (such as in the

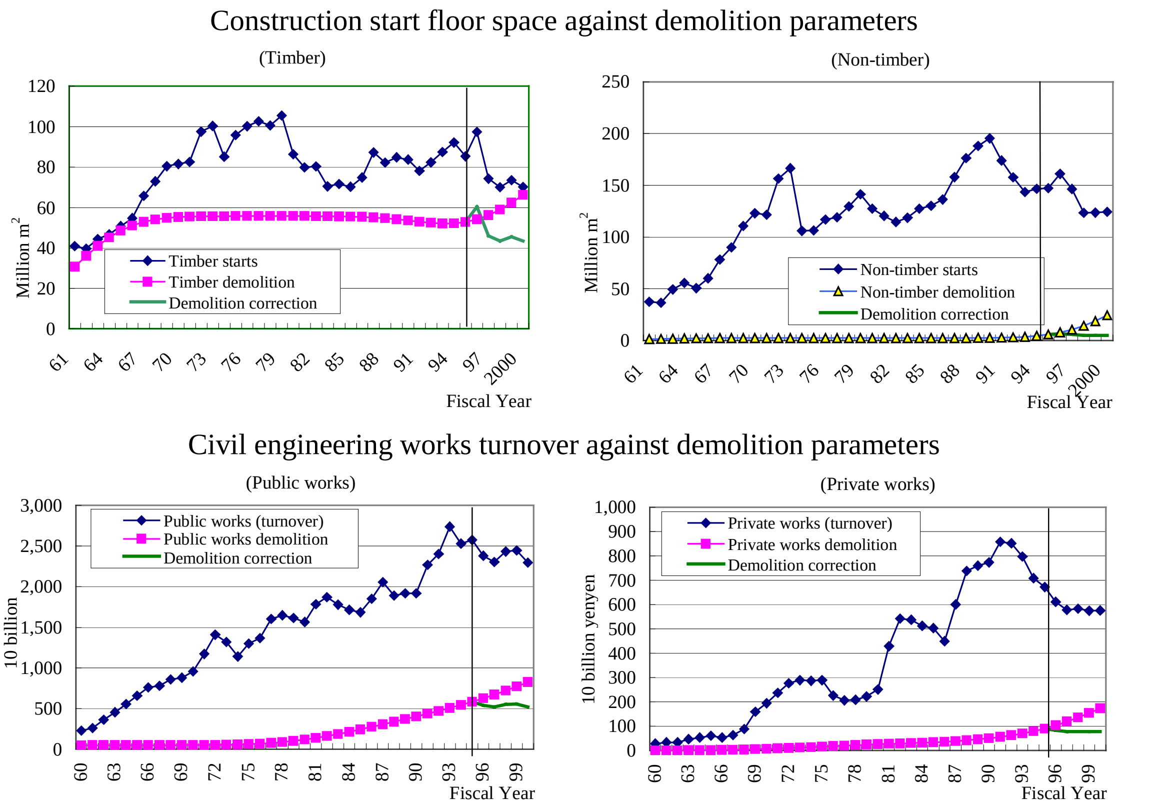


Fig. 1-11 Construction Start Floor Space / Civil Engineering Works Turnover Against Demolition Parameters

era of rapid growth) are hardly reflected at all. The no change scenario could be seen as describing developments in which, unless accompanied by new construction, buildings and structures are not demolished but are left as they are even after reaching the end of their service life.

As stated above, this survey aims to examine the impact associated with the demolition of buildings and structures that have been accumulated to date, taking temporal variations into account, and to pursue debate on the long-term development of this impact. The following discussion will thus be based on the rapid increase scenario.

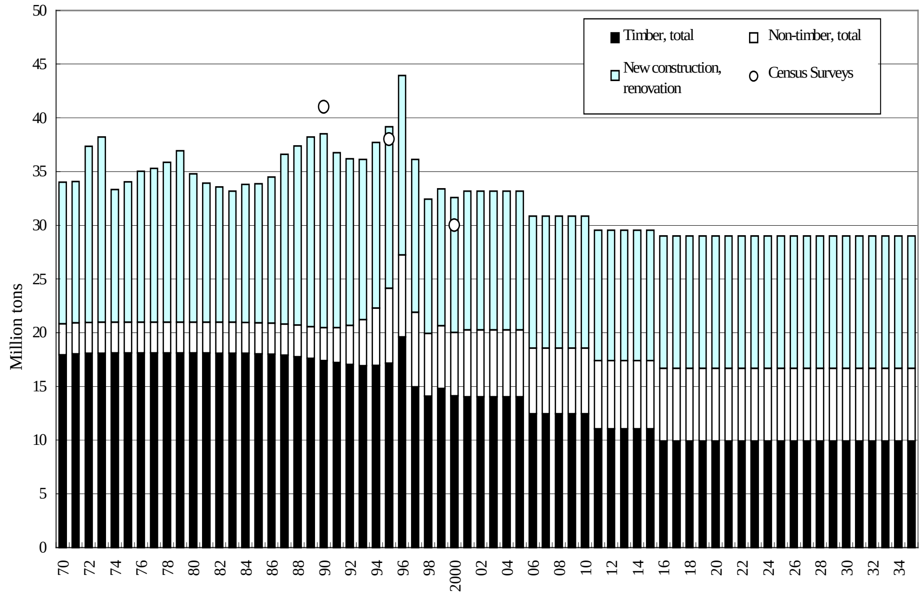


Fig. 1-12 Output of Wastes from Buildings Based on A "No Change Scenario"

Source: Calculated by the DBJ from Construction Statistics Annual Reports, Outline Records of Fixed Asset Prices, etc., Surveys on Construction Wastes, the Medium to Long-Term Forecast for the Construction Market, etc.

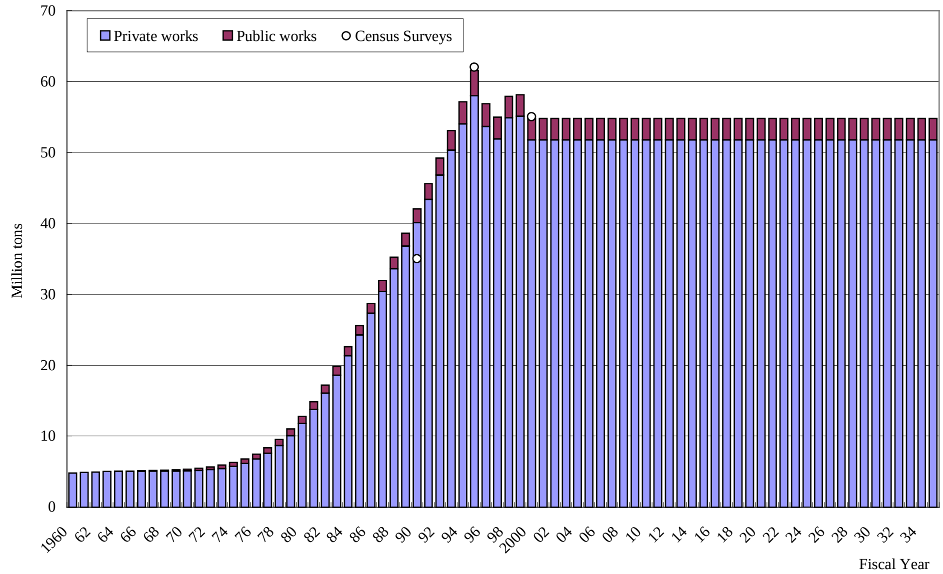


Fig. 1-13 Calculated Output of Construction Waste from Civil Engineering Based on the "No Change Scenario"

Source: DBJ calculations

5. Calculation of the Output of Construction Wastes

5.1 Trends in the Output of Construction Wastes

Figure 1-14 shows overall trends in the output of construction waste (excluding waste construction soil), after aggregating the output from buildings and civil engineering obtained in the rapid increase scenario calculations above. The output of construction waste in Japan, mainly involving public works and non-timber buildings, is expected to increase dramatically in the long term, rising nearly 2-fold from the fiscal 2000 level to just over 300 million tons in fiscal 2010 and nearly 3-fold to more than 400 million tons in fiscal 2030. Fig. 1-15 shows the relative contribution to the rate of change by different outsourcing sectors. A high increase rate of 7.5% per annum is forecast overall between fiscal 2000 and 2010, and since buildings from the 1970's will reach the renewal phase in that period, the contribution of demolished non-timber buildings will be very large. Fig. 1-16 breaks this down into waste concrete, waste asphalt concrete, timber, and other materials. If we extrapolate the composition per material at the fiscal 2010 stage, waste concrete will account for the majority, as seen in Fig. 1-17. Together with waste asphalt concrete and waste construction timber, moreover, it will account for 80% of the total. Fig. 1-18 shows the relative contribution of each material to the rate of change in the output of construction wastes. The contribution of waste concrete is large over the next ten years, reflecting the increased demolition of non-timber buildings.[4]

[4] It should be borne in mind that this calculation takes no account of vegetation uprooting in the course of construction or civil engineering works. When shrubs are cleared in land reclamation and other works, large quantities of roots need to be processed. In the timber industry, too, large amounts of branches and leaves also have to be removed before the wood can be shipped as timber. One source estimates this at more than 100 million tons every year. However, many of these materials have conventionally been incinerated and are completely unknown quantities. In legal interpretations, too, uprooted timber arising from construction works in forest and woodland areas is not regarded as waste, and since no official quantification has been made it has been excluded from these calculations.

5.2 Problems with Waste Construction Soil

Another problem that we cannot ignore when considering the issue of construction waste is that of soil excavated during construction works (waste soil). According to the Census Survey of fiscal 2000, the output of this was around 280 million cubic metres (about 500 million tons). Although this was far less than the 446 million cubic metres (around 860 million tons) recorded in the fiscal 1995 Survey, the volume still far outstrips the total of all other construction wastes. Until now, however, this has not received attention as a problem related to construction "waste", since it is distributed as a commodity, mainly for inland use when elevating farmland or housing land, filling valleys, and so on (Fig. 1-19).

Nevertheless, in view of future output trends and the impact of the problem of soil pollution (which, as mentioned above, is also giving rise to much social concern and is subject to ongoing debate on the introduction of legislation), it is anticipated that waste construction soil will also become a major point of debate in connection with processing construction waste in the near future.

Figure 1-20 shows calculations of the output of waste construction soil from civil engineering,[5] which accounts for the majority of its transportation volume, based on data used until now. Waste construction soil brings up another problem in the relationship with the Census Surveys. Along with the slowdown in the flow of new construction works, we cannot ignore the impact of increased recycling of waste construction soil for other uses among construction sites, due to advances in information technology, on the vast reduction in output indicated by the Census Survey mentioned above. In other words, it is possible that the output base unit has changed structurally with the increase in re-use on site, rather than merely being due to temporary factors. Therefore, in this survey we use a new output base unit for fiscal 2000 onwards.[6]

[5] According to the fiscal 1995 Census Survey, 90% of the total transported volume originated from civil engineering works.

[6] We have calculated demolition parameters for civil engineering works in fiscal 2000 and an output base unit

For reference, the dotted line in the diagram shows what would happen if the old base unit were still used after fiscal 2000 without incorporating these changes. This takes account of the possibility that on-site re-use could be hindered due to the progress of soil pollution countermeasures (to be discussed later), in which case the output base unit would once again increase.

According to this calculation, the output of waste construction soil will grow to 1.6 times the fiscal 2000 level in fiscal 2010, and around double that level in fiscal 2030, increasing massively in future in the same way as the other waste.

As we have seen so far, there is concern in Japan, now approaching the renewal phase of stock on a vast scale, that the output of construction waste in future could expand at a very dramatic rate. Therefore, based on this situation and future prospects, what policies are being developed, and what are the business trends?

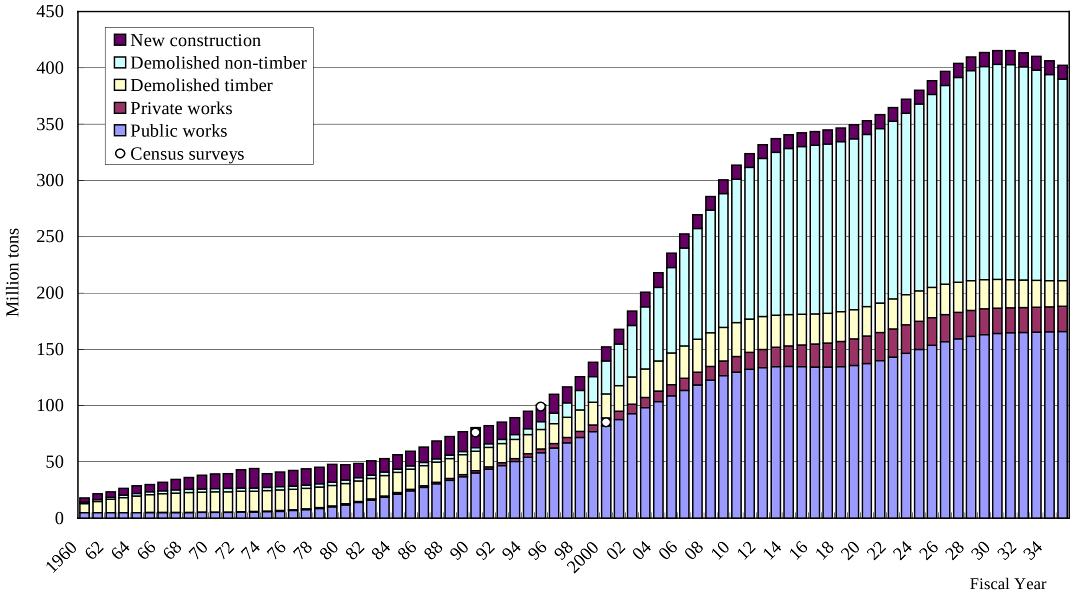


Fig. 1-14 Calculated Output of Construction Wastes
(excluding waste construction soil)

Source: DBJ calculations

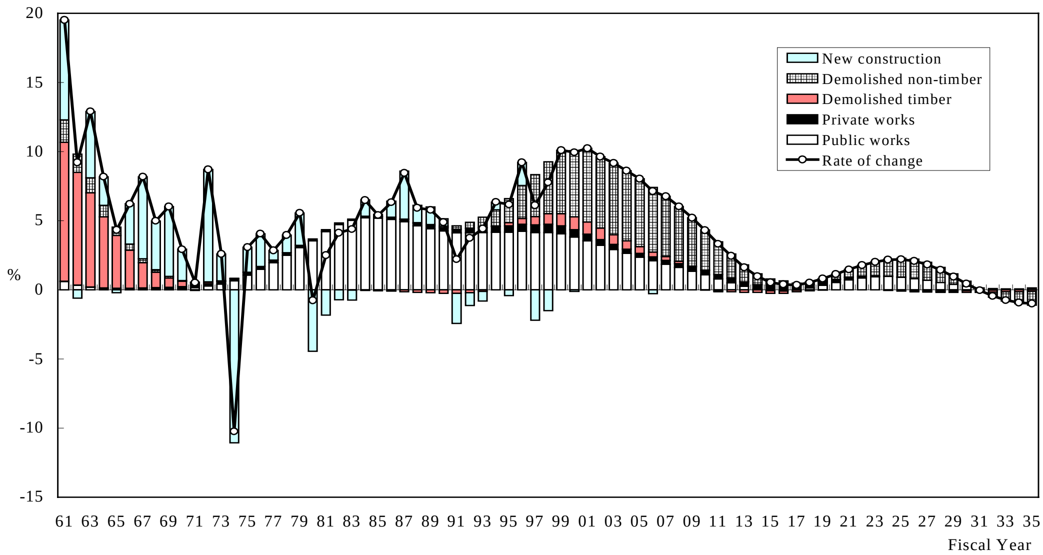


Fig. 1-15 Contribution per Outsourcing Sector to the Output of Construction Wastes

Source: DBJ calculations

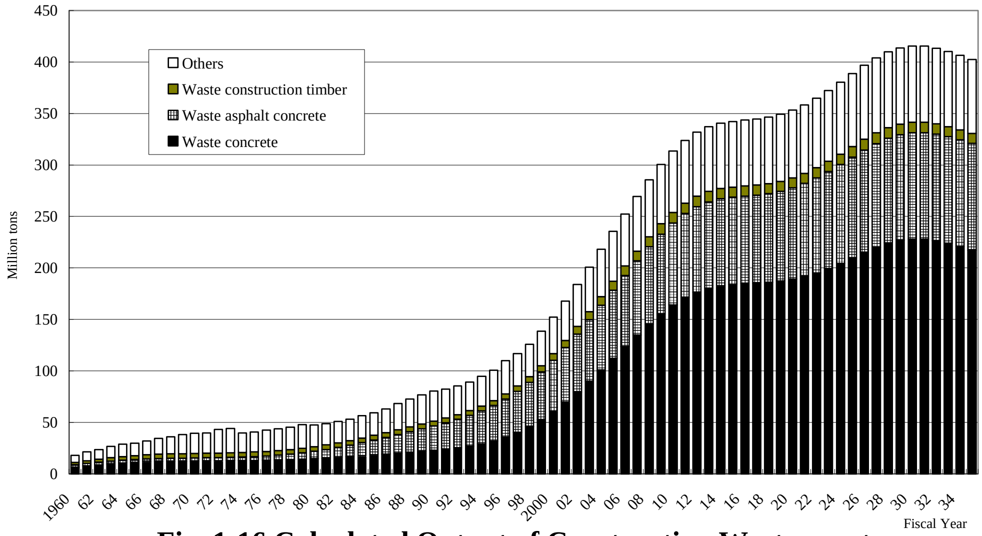


Fig. 1-16 Calculated Output of Construction Waste, per type

Note: Buildings (new construction) are included in “Others”.
Source: DBJ calculations

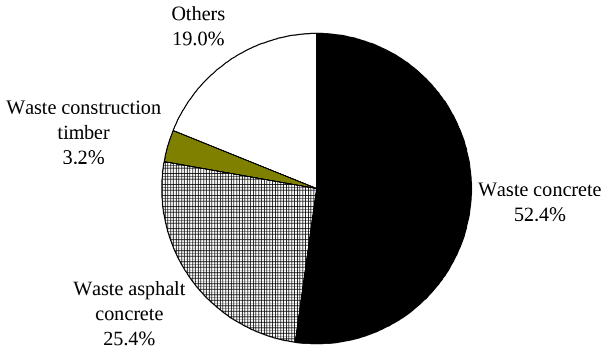


Fig. 1-17 Composition of the Output of Construction Wastes, per type (2010)

Source: DBJ calculations

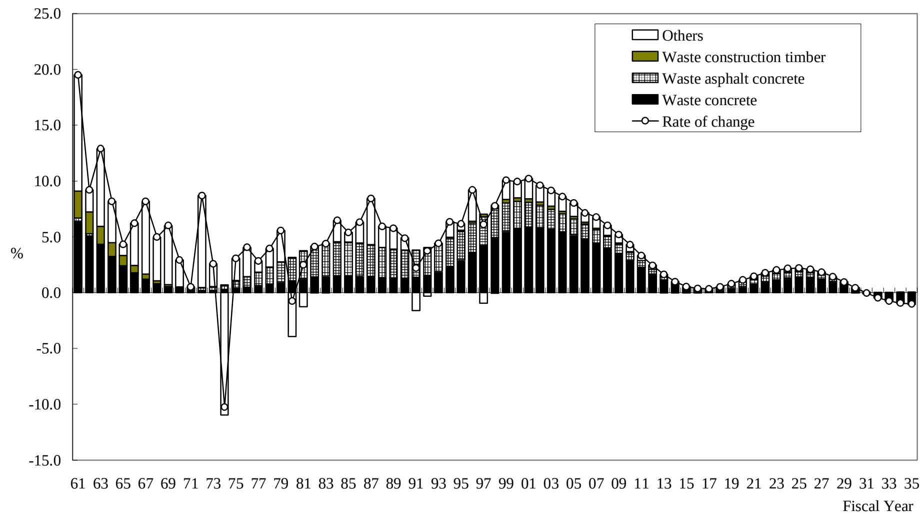


Fig. 1-18 Contribution to the Output of Construction Wastes, per type

Source: DBJ calculations

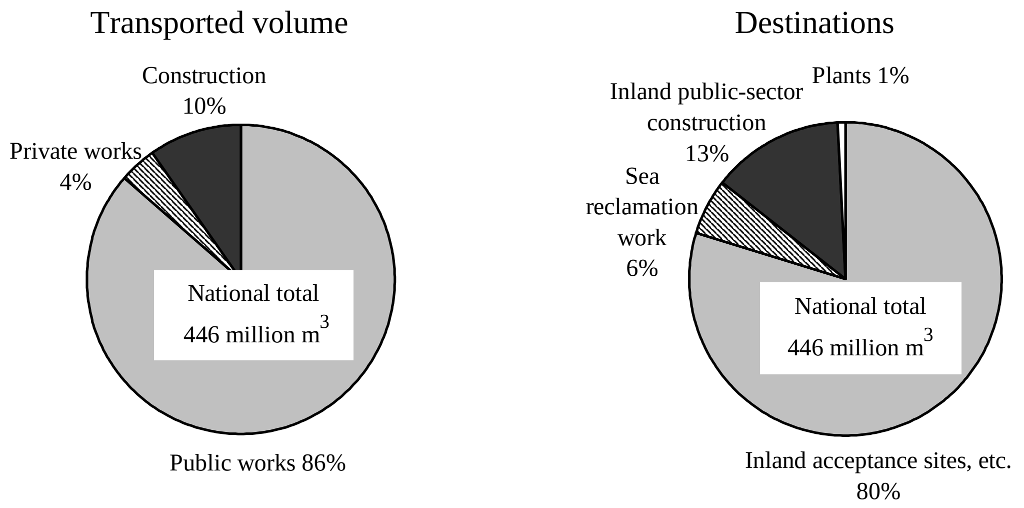


Fig. 1-19 Transported Volume of Waste Construction Soil and Composition of Destinations (FY1995)

Source: Survey on Construction Wastes

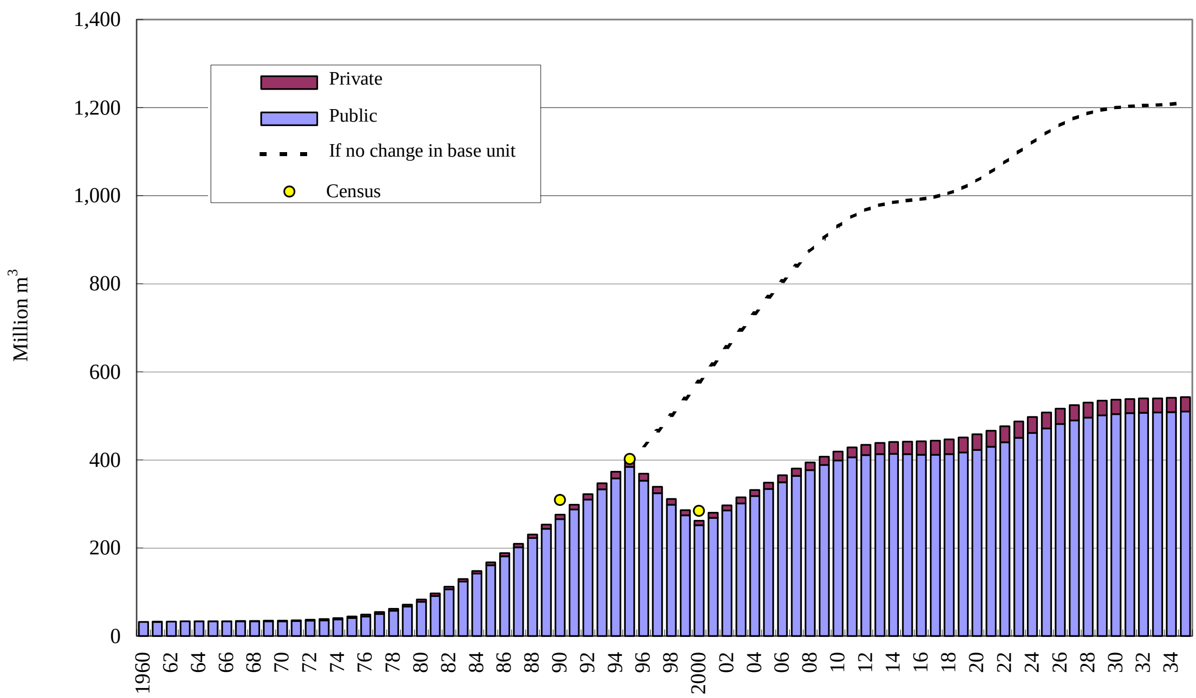


Fig. 1-20 Calculated Output of Waste Construction Soil from Civil Engineering Works

Source: DBJ calculations

II Recycling Industries and the Impact of the Construction Materials Recycling Act

Concern over the dramatic increase in the output of construction waste is spurring a response in terms of government policy. The development of this policy, in turn, will have a big impact on trends in industries that process construction wastes. A similar development has been noted in the past, when the sector known familiarly as the "environmental industry" expanded in scale by working in parallel with the development of direct regulation and other environmental policies. In this section, we will examine the response from the policy angle in connection with construction wastes, as well as trends in construction recycling industries based on this.

1. Present State of Construction Waste and the Construction Materials Recycling Act

1.1 Present State of Construction Waste

As a premise for considering the policy response on construction wastes, we should first sum up the state of processing until now. The output of industrial waste in Japan has been at the level of 400 million tons per year in recent times. The weight of the construction industry within this, as shown in Fig. 2-1, is around 20%, exceeded only by agriculture and the electricity, gas, heating, and water supply industries. Fig. 2-2 shows the state of processing of this waste according to the results of the aforementioned Census Surveys. Comparing construction waste to all industrial waste, the re-use rate is higher, but there is little reduction in volume and the weight of final disposal is consequently much higher. The relatively high re-use rate is due to the fact that waste concrete and waste asphalt concrete (Fig. 2-3), which account for a high proportion of output, have been re-used efficiently so far. The high rate of final disposal, conversely, could be seen as showing that the re-use of other waste, such as sludge, has hardly advanced at all. In Japan, the capacity of final disposal sites (landfill sites) has always been tight. But the situation has been aggravated by the tightening of regulations, such as the amendment to the Waste Disposal Law. Therefore, reducing the disposal volume arising from construction, which accounts for a large part of the capacity, has been targetted as a major task[7].

Meanwhile, construction waste has also become a huge problem in terms of illegal dumping. As shown in Figs. 2-4 and 2-5, construction waste accounts for 72% of cases and 44% of the weight of illegal dumping. This is said to be due to so-called "mince demolition", now prevalent in the industry due to the lack of a monitoring system on the demolition of buildings. Cases of illegal dumping are actually in an increasing trend (Fig. 2-6). Construction waste has, therefore, also become a major point of focus from the point of view of reducing the environmental burden accompanying inappropriate processing.

1.2 Introduction of the Construction Materials Recycling Act

To cope with this anticipated expansion in output as well as improving this present state of construction waste, the Construction Materials Recycling Act introduced in May 2000. The Act sets out to establish a new framework for processing construction waste by imposing obligations to sort and recycle "specific construction materials" on construction works exceeding a certain scale. An outline of the Act is shown in Table 2-1 At the same time, a registration system was introduced for demolition contractors, including a requirement that technical supervisors be assigned to demolition sites, in an attempt to

[7] The 1997 amendment to the Waste Disposal Law, along with the consequent amendment of orders on technical standards, has tightened the structural and maintenance standards applicable to landfill sites. As a result, the number of newly created sites, registering more than 100 every year up to fiscal 1998, fell sharply to only 26 in fiscal 1999. The conventional modus operandi, whereby the reduction in capacity of existing sites is compensated by newly created ones, is therefore becoming increasingly difficult to maintain. As for construction waste, meanwhile, the discovery of arsenic elution from plaster boards, which had until then been disposed in least controlled type landfill sites, was changed to controlled type disposal from 1999. This presents another factor that places pressure on landfill site capacity.

raise the level of demolition works.

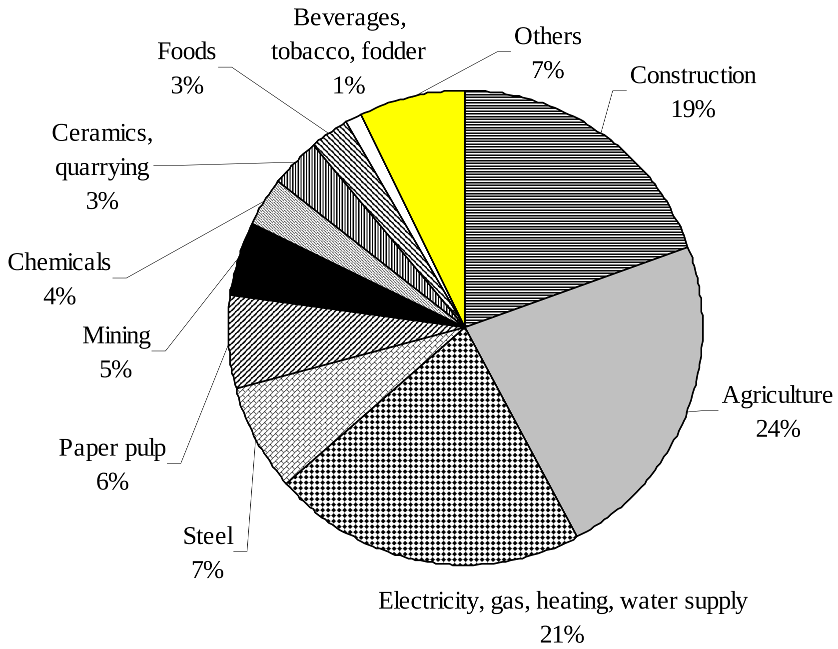


Fig. 2-1 Output of Industrial Waste, by sector (FY1998)

Source: Ministry of the Environment, "Survey on the Output of Industrial Waste and the State of Processing" (1998)

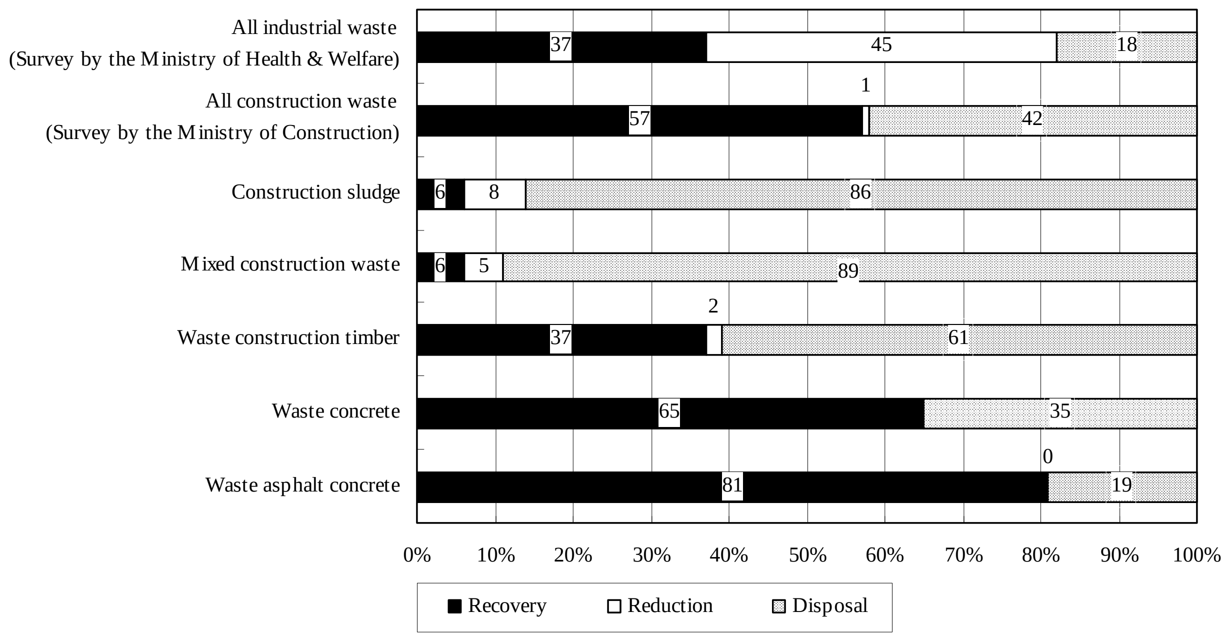


Fig. 2-2 Comparison of Recovery Rates, etc.

Source: Council for PR and Promotion of Construction Waste Recycling, "Comprehensive Measures for Construction Wastes" (FY1999 edition)

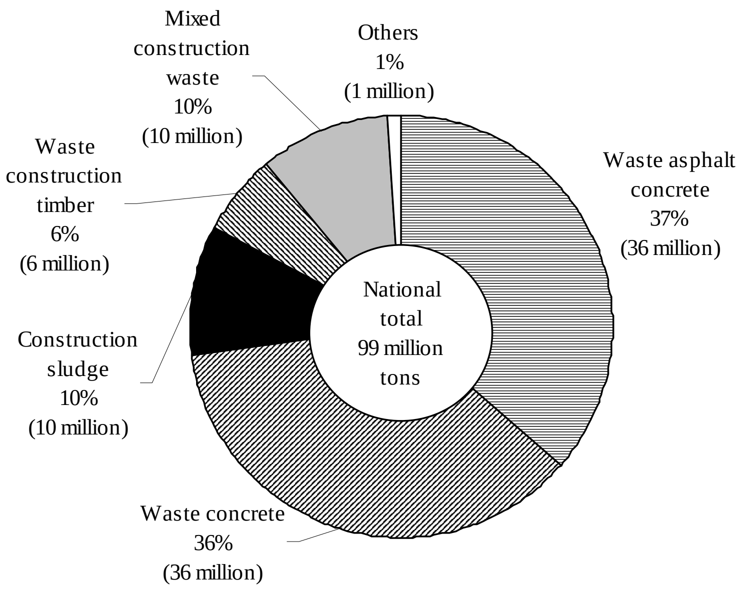


Fig. 2-3 Composition of Construction Waste Output, by type (1995)

Source: FY1995 Survey on Construction Wastes

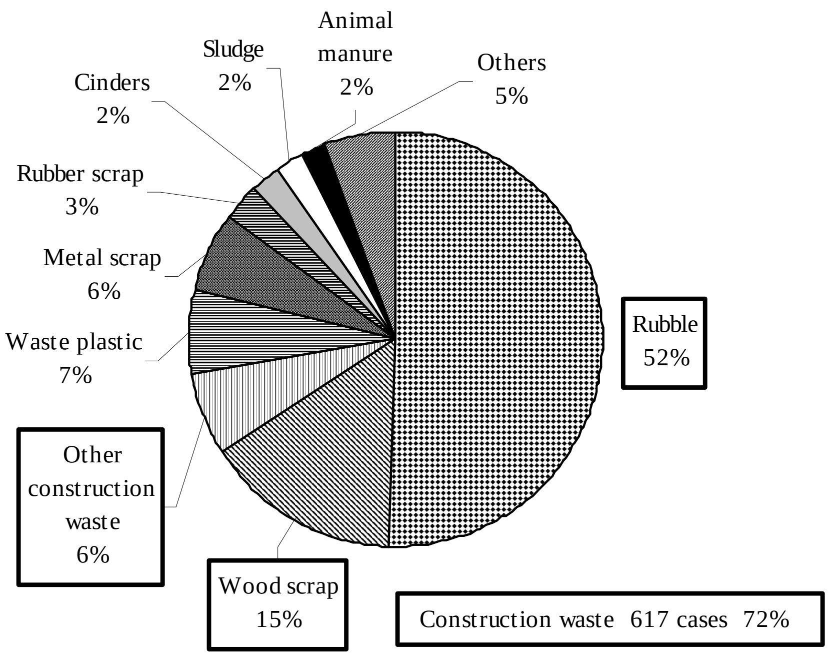


Fig. 2-4 Composition of Illegally Dumped Industrial Waste (cases, FY1997)

Source: Ministry of the Environment

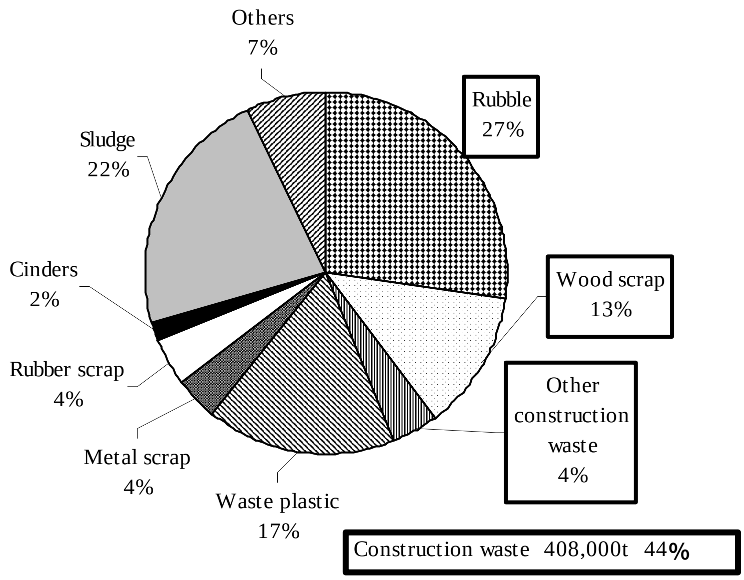


Fig. 2-5 Composition of Illegally Dumped Industrial Waste (weight, FY1997)

Source: Ministry of the Environment

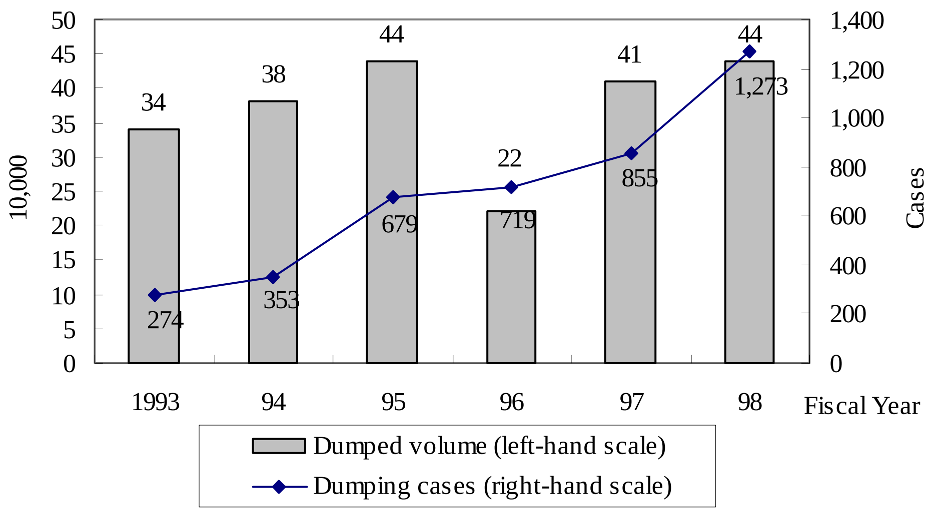


Fig. 2-6 Trends in Cases and Volume of Illegally Dumped Industrial Waste

Source: Ministry of the Environment

Table 2-1 An outline of the Construction Materials Recycling Act

Name	Law for the Recycling of Construction Materials (Law No. 104 of May 31st, 2000)
Enforcement	Basic principles (roles of parties concerned, recycling targets, etc.): Took effect on Nov. 30th, 2000 Registration system for demolition contractors: Took effect on May 30th, 2001 Obligation to sort and recycle, etc.: To take effect from May 2002
Purpose	To promote sorted dismantling and recycling of specific construction materials, and to secure resources and ensure appropriate processing of waste by making full use of recycled resources, reducing waste, etc.
Specific construction materials	The following when exceeding a certain scale: (1) Concrete (including secondary products derived from concrete and steel) (2) Asphalt concrete (3) Timber
Targeted works	• Demolition of buildings and others that use specific construction materials • New construction works using specific construction materials → Demolition 80m^2 or more / New construction 500m^2 or more / Civil engineering works 5 million yen or more (to be decided officially in government ordinances by June 2002)
Recycling targets	Recycling rate in FY2010 = 95% (recycled weight / output weight)
Key points	• Obligation to sort dismantled materials, etc. • Obligation to recycle, etc. (for timber, reduction allowed under certain conditions) • Obligation for prior notification (to prefectural governor) of works by works orderers, post-completion reports from contractors to works orderers, etc. • Clear indication of demolition costs in contractual documents • Registration system for demolition contractors (from June 2001) and obligation to assign technical supervisors to demolition sites, etc.

Source: Collated from various materials

Specific construction materials are those which, (1) on conversion to waste, should be recycled to ensure effective utilization of resources and reduction of waste, and (2) are not subject to significant financial constraints when recycling, as stipulated by government ordinances (Article 2 Paragraph 5 of the Act). So far, four materials have been designated, namely (i) concrete, (ii) construction materials made from concrete and steel, (iii) timber, and (iv) asphalt concrete.[8]

Contractors and others accepting orders for work above a certain scale, when coming under the provisions of the Act, are obliged to sort specific construction materials on site via sorted dismantling and other means (Article 9 Paragraph 1 of the Act), and to recycle said materials (Article 16 Paragraph 1 of the Act). "Contractors and others" here is a broad concept including everyone involved in the construction work as subcontractors, as well as the principal contractor. "Recycling", meanwhile, is a concept that includes both material and thermal recycling. However, "designated construction waste" as stipulated in government ordinances may simply be "reduced" (incinerated, etc.) as appropriate when subject to certain conditions, such as the existence of significant financial constraints when recycling.[9]

The characteristics of the Construction Materials Recycling Act may be summarized into the following three points.

The first is that it provides for role-sharing between a wide range of related parties, reflecting the wide range of parties involved in construction works. Fig. 2-7 shows the flow when sorting and recycling dismantled materials. For the contractors who play central roles in construction works, the Act imposes an obligation for notification, etc., between principal contractors and subcontractors. Works orderers are also obliged to submit plans for sorted dismantling, etc., to the prefectural governor, and to specify the method of sorted dismantling, and the costs

[8] Ordinance No. 495 of 2000. Generally, (ii) construction materials made from concrete and steel are regarded as secondary concrete products and, as such, are included under concrete, bringing the number of designated materials down to three. Therefore, in this survey, the targets of the Act will be treated as the three materials of waste concrete, waste asphalt concrete, and waste construction timber.

[9] This applies to timber.

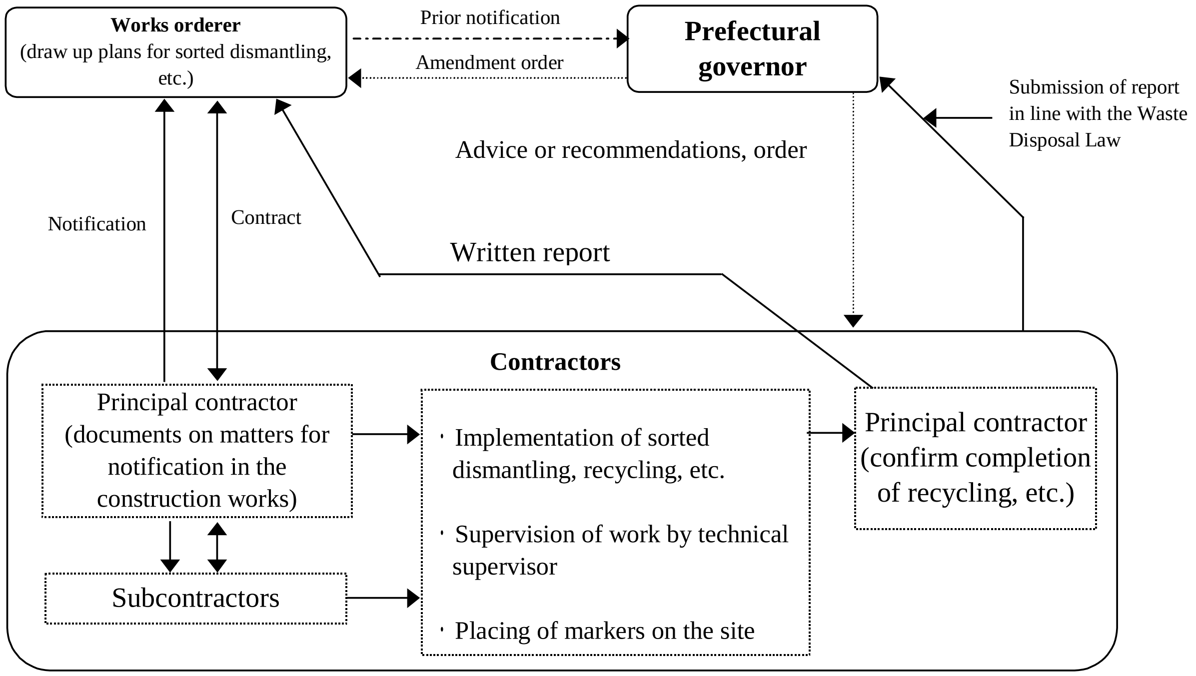


Fig. 2-7 Flow of Construction Material Recycling

Source: Ministry of Land, Infrastructure and Transport

involved, in the construction work contract. In ways such as this, the Act has devised a framework whereby all parties involved are aware of the method of sorted dismantling, etc., and the costs involved in it.

Secondly, a point related to the foregoing is that the role played by prefectural governors in this whole process is very large. Prefectural governors determine the directions for application of the Act by formulating guidelines and supplementary by-laws, but also monitor various notifications concerning sorted dismantling, recycling, etc., and give guidance whenever necessary. In such respects they are expected to play a more prominent role than in other environment-related legislation. Regional characteristics have a significant influence on construction waste (for example, the volume generated, the existence of processing infrastructure, the remaining capacity of landfill sites, the ease or difficulty of procuring natural materials that compete with recycled materials, and so on). This factor could be seen as contributing to this point.

The third point is that the Act represents a system design that leaves room for future amplification based on reality. In terms of making effective use of resources, the option of adopting a wider range of materials for recycling, etc., could also exist.[10] But taking the viewpoint of developing a recycling system that can guarantee economy and then amplifying it, the rational choice would appear to be to focus on waste concrete and waste asphalt concrete, for which recycling is already relatively advanced. Even in terms of correcting the present situation, positive effects can be expected from the inclusion of timber (for which recycling is slow to develop, while incineration is becoming more difficult due to tighter regulations on dioxin, etc.), as well as from the built-in system of monitoring demolition businesses (the registration system), leading to countermeasures against illegal dumping. In future, when proper processing infrastructure is in place and the flow of materials into it is guaranteed, it will be easy to expand into construction materials that are difficult to process properly at present, such as used plastic and plaster

[10] In fact, the Tokyo Metropolitan Government is reportedly considering independently adding plastic (PVC pipes and joints), plaster boards, and others to the materials subject to recycling in fiscal 2002, in addition to the three materials designated by the Act.

boards. This direction, indeed, has already been highlighted in the "Basic Principles of the Construction Materials Recycling Act" drawn up by six relevant ministries and agencies at the end of 2000.

2. Recycling Industries and the Impact of the Construction Materials Recycling Act

2.1 The Construction Waste Recycling Market (intake theory)

Next, let us consider what impact the introduction of this Construction Materials Recycling Act will have on the recycling industries that deal with construction wastes. First, the impact of the Act will be examined based on the scenario of a dramatic increase in output, as discussed above. Following the enforcement of the Act, the recycling rates of the three materials designated as "specific construction materials" (waste concrete, waste asphalt concrete, and waste construction timber) will be increased to 95% by fiscal 2010. The additional processing demand arising from this in future may be regarded as the difference between the levels sought by the Act and the levels if processing were continued at present rates, as shown in Table 2-2. The results of this calculation are shown in Fig. 2-8. According to these results, the future increase in output, added to the improvement in recycling rates as sought by the Act, would bring the additional volume requiring processing to around 120 million tons in 2010, continuing to increase gradually thereafter. Waste concrete, whose output is set to increase dramatically, would account for the larger part of the weight composition (Fig. 2-9).

Table 2-2 Calculation Conditions

Material		Current processing basis	Recycling progress line (FY2010)	Remarks
Waste concrete		50 million tons/year	95% of output	Mostly used as basecourse material. To be expanded for re-use in construction materials
Waste asphalt concrete		85% of output	95% of output	Usage to remain as at present
Waste construction timber		40% of output	95% of output	Present state → use of reduced materials, improvement through advance of material recycling
Others	Construction sludge	14% of output	14% of output	No improvement foreseen in this calculation
	Metal scrap	100% of output	100% of output	No improvement foreseen in this calculation
	Others	11% of output	11% of output	No improvement foreseen in this calculation

* Since recycling includes intermediate treatment, the remainder is the finally disposed volume.
* Assuming the progress line is reached at an average rate from the base line (FY2001).

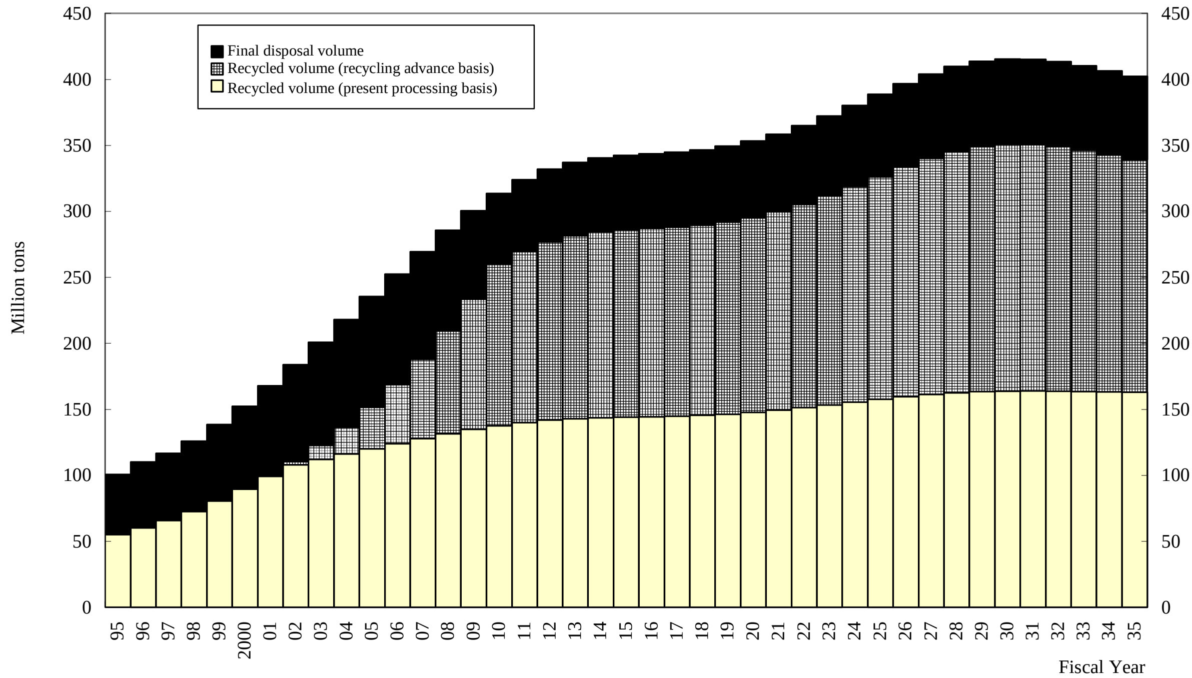


Fig. 2-8 Calculated Additional Processing Volume with the Advance of Recycling

Source: DBJ calculations

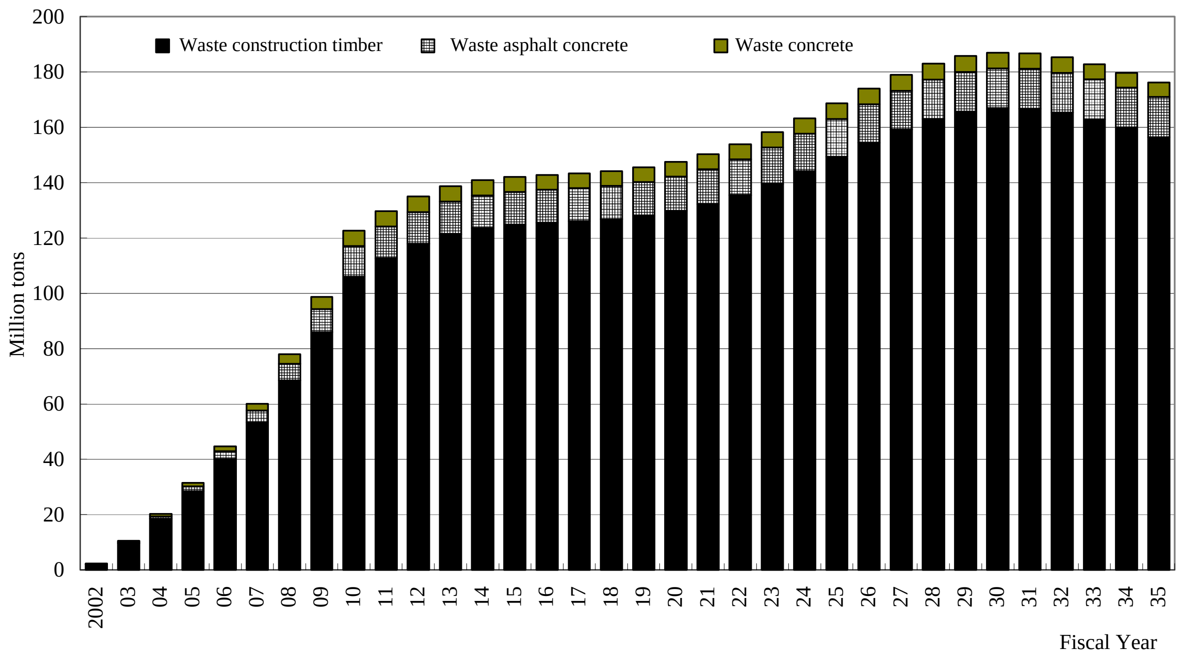


Fig. 2-9 Trends in Additional Processing Volume per Material

Note: The graph shows the difference between a scenario in which recycling rates for waste concrete, waste asphalt concrete, and waste construction timber are improved in line with the Construction Materials Recycling Act, and one in which present processing levels are maintained. Construction sludge, metal scrap, and others not targetted by the Act do not appear on the graph as they will remain unchanged.

Source: DBJ calculations

These materials would be processed in dedicated plants before being returned to construction sites and elsewhere as recycled resources. Fig. 2-10 shows the market scale of the construction recycling industry including this additional volume, assuming that recycling costs (acceptance basis) remain unchanged from present levels. It should be noted that “recycling costs (acceptance basis)” here, as shown in Fig. 2-11, are only the acceptance costs at the intermediate processing stage and do not include transportation costs. The latter have been omitted because they vary greatly, depending on the location of the works site. According to this estimate, the market scale of the construction recycling industry would reach around 800-900 billion yen per year overall, with around 400-500 billion yen of new recycling requirements added to the existing scale of around 300 billion yen per year.

It should be remembered, however, that this kind of calculation invariably entails a number of limitations. In this particular case, the first limitation is the handling of waste construction timber. Even with the enforcement of the Construction Materials Recycling Act, there is a considerable volume of waste timber that cannot realistically be recycled due to financial constraints, and reduction is the most that can be expected. This point has not been incorporated in our calculations, since future developments concerning incinerators are unclear. Following a tightening of regulations, such as amendments to the structural and maintenance standards of industrial waste incinerating facilities, many existing facilities were expected to be decommissioned as they could not meet the massive structural improvement costs needed to clear the new standards. But in fact, many operators are reportedly continuing in business because, among other reasons, repeat licenses are very difficult to obtain once an incinerator has been decommissioned. This makes it difficult, at the present time, to judge future developments of receptors for waste timber from demolition.

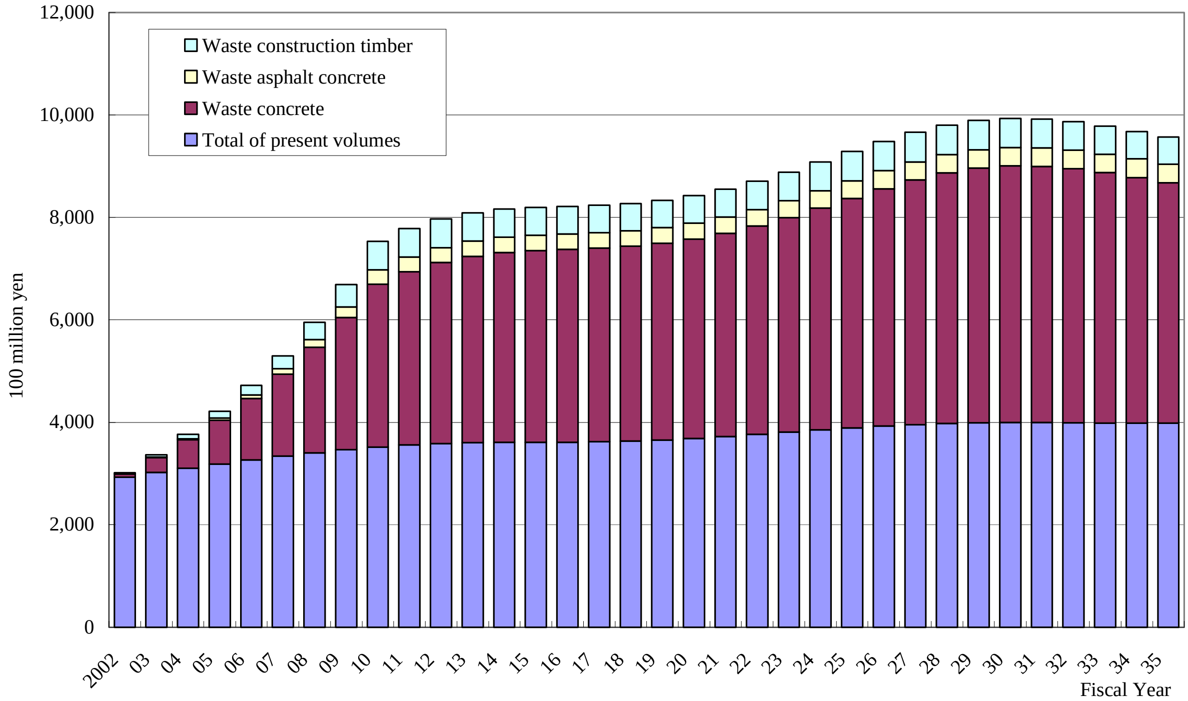
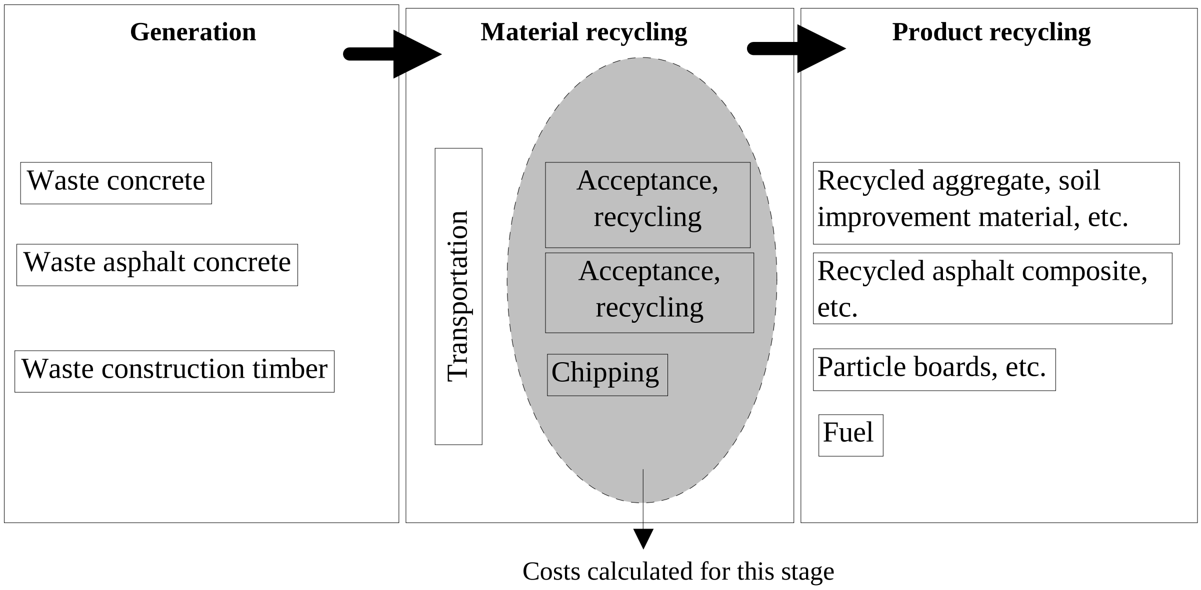


Fig. 2-10 Calculated Market Scale of Construction Recycling

Source: DBJ calculations



Assumed acceptance costs:	Concrete mass	3,000	yen/t
	Asphalt concrete mass	2,500	yen/t
	Wood scrap	10,000	yen/t

Fig. 2-11 Conditions for Monetary Conversion

The second limitation is that the discussion so far has assumed that output base units will remain constant. Of course, the base units in themselves will tend to fluctuate with time. Therefore, if sorting on site progresses in line with the gist of the Act, the potential for use on site would increase in future and the ratio of the transported volume to the generated volume would very likely fall. But since there are no proper data for this, it has not been incorporated in our calculations. As an exercise, Fig. 2-12 shows what would happen if the output volume decreased in stages due to re-use on site (the output base unit decreasing by 10% every 5 years from FY2002 onwards, remaining level thereafter). But even then, the market scale would be significantly effected on the intake side.

The third limitation is the problem of processing costs. Here, we are assuming a level close to present costs for intermediate processing. The possibility exists, however, that these could be greatly affected by future price trends, such as increased output or technical innovations.

Thus, it should be noted that, even if it is mistaken to assume that the market scale of the recycling market (the volumes that ought to be handled) in terms of intake theory will expand in future, the debate will vary greatly with even small fluctuations in a large number of preconditions.[11]

[11] In particular, it is possible that the scenario of a rapid increase in output could be corrected if longer service life could be achieved through future improvements in maintenance or repair technology. This point will be handled in 3 below.

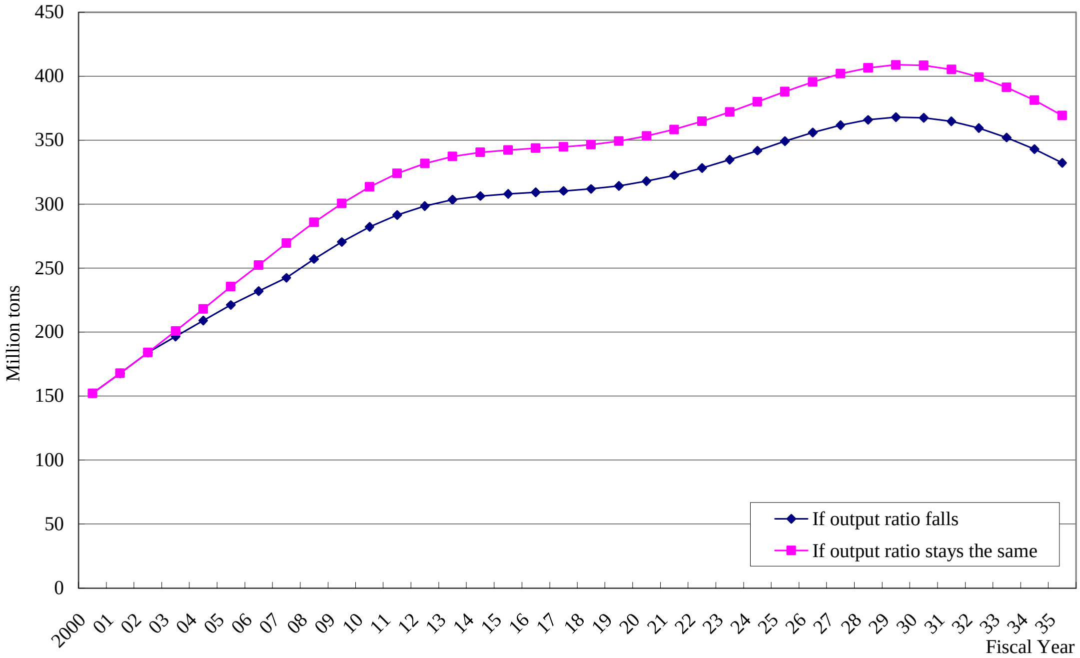


Fig. 2-12 Impact if the Output Ratio Falls

Source: Compiled by DBJ

2.2 Problems of Receptors for Recycled Resources (outlet theory)

When considering the impact on the recycling industry, a bigger problem is that of the receptors (outlets) for recycled resources. Recycling businesses take two forms, namely (1) accepting generated waste for processing (service industry) and (2) processing the accepted materials and marketing them as raw materials, etc. (processing industry). To put it simply, if the costs associated with (1) and (2) could be absorbed by revenue from processing (1) and manufacture and sale (2), the business would be operable. In reality, however, this is not so easy to achieve. In many cases, the reason for this can be found in the weight of the cost burden and the fact that revenue in the processing industry is small and unstable. Therefore, when discussing recycling businesses, we need to consider the aspects of marketability of recycled resources and cost, as well as the market scale discussed above (revenue for the processing industry).

Firstly, in terms of the marketability of recycled resources, the majority of materials in material recycling undergo "cascade recycling",[12] in which the usage goes down to a lower level. Receptors for these are in a state of oversupply, and they are low in marketability. In thermal recycling, similarly, when undertaken purely as a private sector business, sale power is treated as surplus power generated in-house, and the sale power price is at an extremely low level.

What form does this take in construction recycling? As shown in Fig. 2-13, waste concrete and waste asphalt concrete, whose recycling rates have been relatively high until now, are used as crushed stone, the main destination being basecourse, subgrade, and other materials for use in roads. However, this use also has limited potential for absorbing the future expansion of output. As Fig. 2-14 shows, the demand for basecourse materials is around 200 million tons per year. Fig. 2-15, meanwhile, reveals that the supply of aggregate mainly comes from the crushed stone industry at present. If the input of waste

[12] Likening the flow of materials to a waterfall ("cascade"), the uses of recycled materials gradually move down from high- to low-grade levels through the recycling process. This is a concept that complements those of "horizontal recycling" and "upgrade recycling".

concrete from demolition works is increased, however, there will be a conflict of roles with the crushed stone industry. As well as this, basecourse and subgrade are seen as promising destinations for other recycled resources (steelmaking slag, cullet, etc.) and waste processing residue (molten slag, etc.), and competition among recycled resources is expected to become aggravated in future. Expanding recycled material markets could be seen as an urgent task.

Next, from the angle of costs, the very activity of recycling in itself gives rise to additional costs by adding a new flow (reverse flow) of “sorted dismantling → recycling” to the conventional flow of materials (construction → demolition → waste). In particular, when recycled materials have low added value, their ability to ab sorb transportation costs is inevitably limited, and business feasibility is greatly affected by the degree to which these costs can be minimized (e.g. selection of plant location). Moreover, the cost of final disposal of residues left after recycling are bound to go up now that landfill space is becoming harder to obtain, and this is a factor that pushes up the overall cost.

These problems of cost are thought to be particularly manifest in the case of construction wastes, which have a high output and weight.

Overall, then, the recycling industry is subject to a number of constraints, particularly as it is such a highly installation-reliant industry. Quite in contrast to its apparently semi-macro market scale, it is characterized by an opaqueness of business feasibility. In order to clear these hurdles and guarantee feasibility, efforts are needed at both policy and business level.

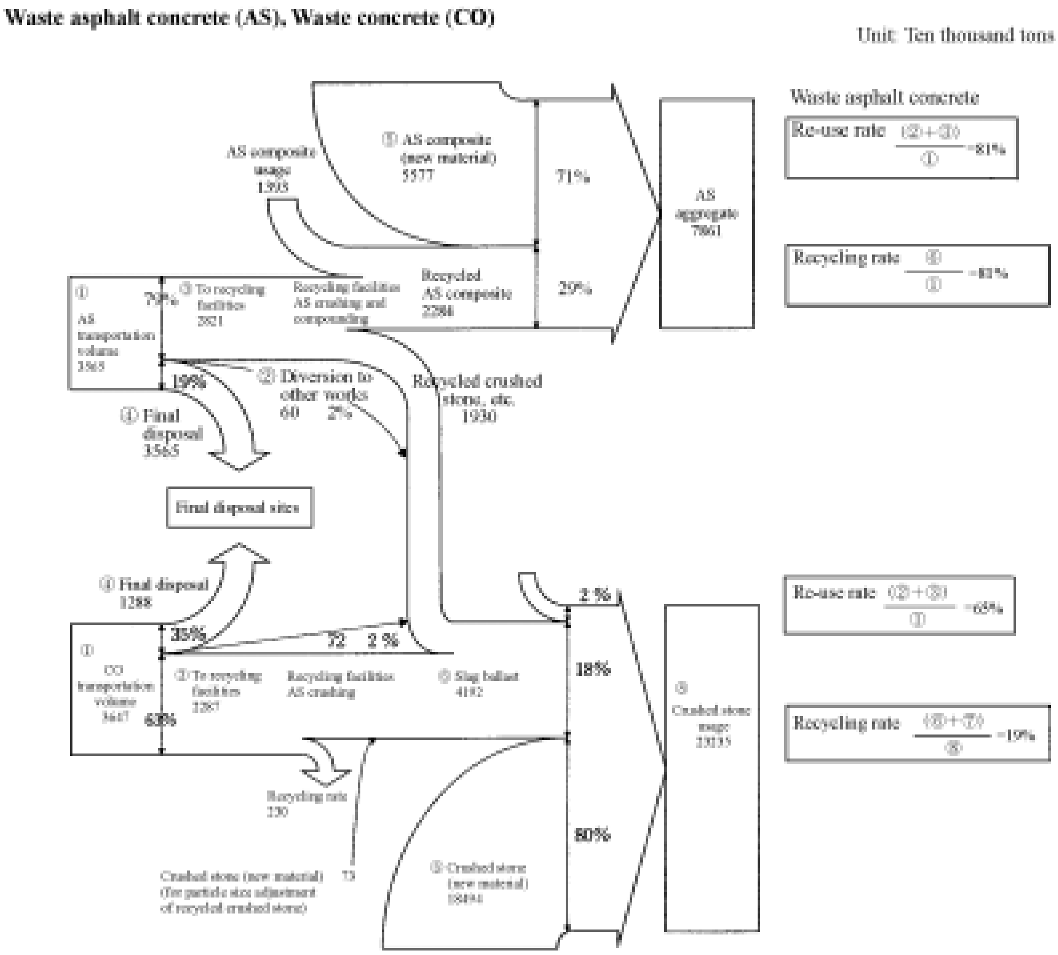


Fig. 2-13 Recycling Flow (FY1995)

Source: Housing and Ceramics Industry Construction Materials Department, Manufacturing Industries Bureau, Ministry of Economy, Trade and Industry

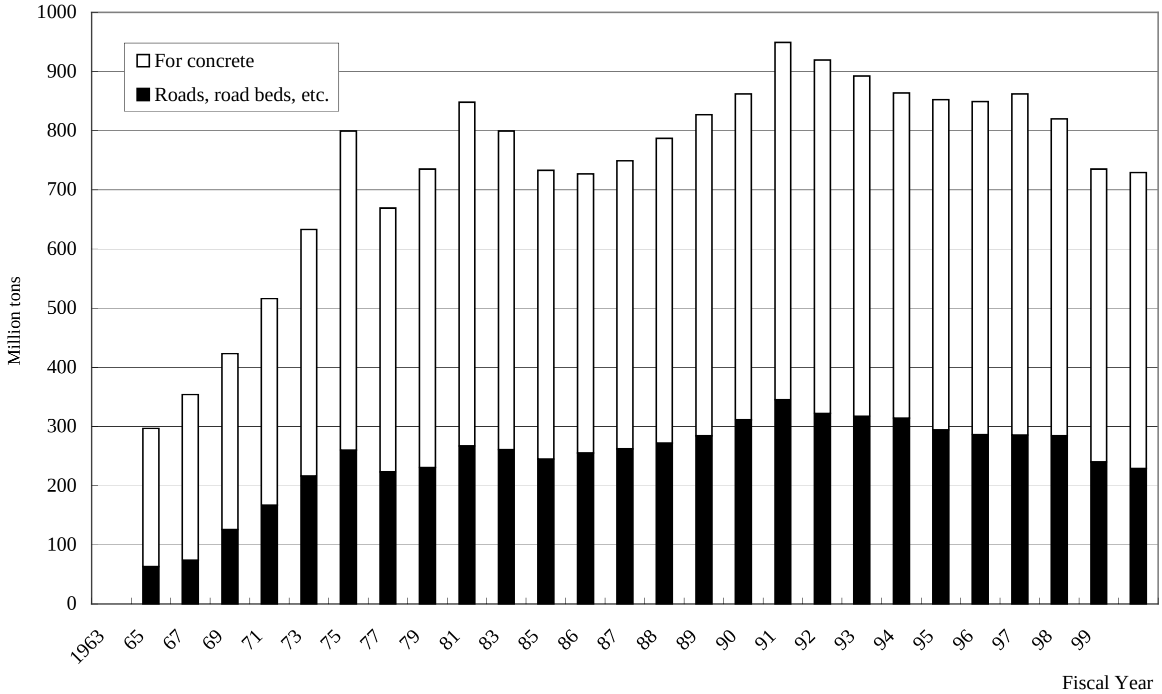


Fig. 2-14 Trends in Demand for Aggregate

Source: Housing and Ceramics Industry Construction Materials Department, Manufacturing Industries Bureau, Ministry of Economy, Trade and Industry

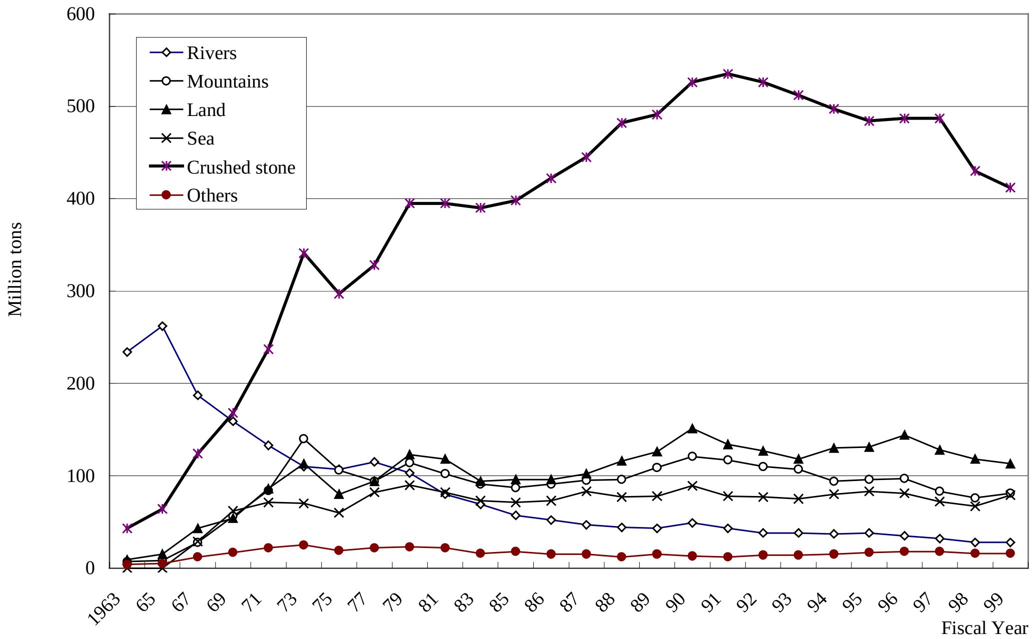


Fig. 2-15 Trends in Aggregate Supply

Source: Housing and Ceramics Industry Construction Materials Department, Manufacturing Industries Bureau, Ministry of Economy, Trade and Industry

2.3 Efforts Aimed at Forming Recycling Industries

What sort of measures, then, have been devised by the industry to address these issues?

In terms of expanding markets for recycled resources, various seeds of technology have been presented for the three materials targetted by the Construction Materials Recycling Act (mainly waste concrete and timber) at the present stage. For other materials, meanwhile, the development of recycling technology is now in progress. Of the three main materials, it is thought possible to maintain the present recycling route (via road repairs, etc.) for waste asphalt concrete in future. The focus, therefore, is now thought to be on the other two materials. Dedicated plants will be needed to carry out the sophisticated recycling process required to broaden the uses of these recycled resources, and this will cause the burden of costs for transportation and other aspects to expand. The seeds that have been presented so far not only concern the issue of recycling technology but also consider means of keeping these costs down. Table 2-3 lists a number of representative examples.

(1) Processing of waste concrete

In terms of expanding the marketability of waste concrete processing, a point of note is that a system of technology aimed at diversifying and stratifying the uses of recycled concrete is now being developed. The purpose in doing so is to add more advanced material recycling such as architectural structures and foundations, depending on quality, to the conventional base of usage as basecourse and subgrade materials.

The technology seeds for horizontal recycling of aggregate recovered from waste concrete into architectural structures include the heating, rubbing and kneading method (Diagate technology) developed by Mitsubishi Materials, included in Table 2-3. Here, roughly crushed waste concrete is heated to 300°C to weaken the cement paste. It is then ground inside a tube mill, allowing fine aggregate and coarse aggregate to be separated and recovered. Waste concrete consisting of 20% concrete paste, 33% fine aggregate, and 47% coarse aggregate yields 25% fine powder, 31% fine aggregate, and 44% coarse aggregate, thus giving an aggregate recovery rate of 94%. This is an extremely high level compared to other processing technology that does not involve heat treatment. The quality of the recovered aggregate is equal to that of natural aggregate, and clears the standards required of aggregate by JIS A5005 (namely an absolute dry density of more than 2.50g/cm^3 and water absorption of less than 3.0%). The quality of concrete manufactured using recycled aggregate is also equal in strength to that using ordinary aggregate, and has, in fact, been proved superior in durability (dry shrinkage) because it has the full range of particle sizes. Because it is still at the demonstration plant stage,[13] the processing costs are high compared to normal aggregate recovery processing. Nevertheless, if recovered fine powder can be launched on the market for ground improvement materials, etc., taking advantage of reduced manpower due to the adoption of a centralized control system and the fact the processing costs could be vastly reduced by upgrading in scale to an actual operating plant. If this technology enters the practical stage, in spite of limitations on volume owing to problems of quality, it would become possible to secure a horizontal material recycling route for some waste concrete to be used in architectural structures.

Assuming this use in architectural structures to be the maximum level, if multi-stage uses could be established below this in the form of middle-level material recycling for foundation works, retaining walls, and others not requiring so much strength as architectural structures, and cascade recycling of basecourse materials, refilling materials, and others, sufficient marketability could conceivably be secured for the recycled materials obtained in this way, even if the volume of generated waste concrete increased. In this case, of course, it would be important to control the quality in keeping with these multi-stage uses. This point will be discussed further below.

[13] A mobile installation type with a capacity of 5t/h. Demonstrations have been underway for two years since fiscal 1998 as a NEDO demonstration plant.

Table 2-3 Examples of Seeds of Technology and Systems for Construction Recycling

Targetted material		Name or description	Main implementing body	Outline
Targetted by Construction Materials Recycling Act	Waste concrete	Recycling for architectural structures	Mitsubishi Materials	Has established technology for recovering high-quality coarse aggregate, fine aggregate, and fine powder by applying a heated grinding process to waste concrete.
				Has developed technology for recycling fine powder to cement with a low environmental burden.
		Concrete resource circulation system	Shimizu Corp.	Cyclical use of recycled resources obtained in Mitsubishi Materials plants. Used in the construction of an acoustic test lab at the company's Technology Research Centre, gathering data obtained from here and continuing technical improvements.
		On-site recycling and use	Kashima Corp.	Uses aggregate processed on-site in actual buildings.
		Reverse concrete	Okumura Corp.	Has developed a system for manufacturing recycled concrete, fitted on a 10-ton truck. Dismantled concrete is re-used on site. Mainly for uses requiring relatively low durability.
		Self-propelled recycling machinery	Komatsu Ltd.	Has strengthened its involvement in self-propelled recycling machinery (Galapagos Series), increasing reserves for development investment.
				Is developing information agency sites to reduce mismatches between supply and demand for recycled resources.
	Waste construction timber	Recycling for construction materials	Sumitomo Forestry Co., Ltd.	Has developing recycled timber with a high ligneous rate, used as woodchips and other materials in housing.
			Sekisui House	Has developed technology for recycling wood scrap generated by housing demolition into joist material.
			Takenaka Corp.	Has constructed a system for sorting and recovering wood scrap generated in the metropolitan region under a universal recovery system, and recycling into particle boards under commission to Tokyo Board Industries.
				Has constructed a system for transporting wood scrap generated in the Kinki region to Tokyo and recycling into boards, as above. In joint operation with Nippon Express Co., Ltd., transportation between Tokyo and Osaka is undertaken using that company's railway containers.
		Use for power generation	NKK	Has commercialized power generation boilers (circulating fluidized bed type) that can use wood scrap as fuel (power generation efficiency more than 30%).
		Use as blast furnace reductant		Has started demonstrations on the use of wood scrap as a reducing agent in the Keihin Seisakusho plant (Oct. 2001). At the same time, is studying a system for recovering required volumes.
		Conversion to cement firing fuel	Taiheiyo Cement	Following on from the Saitama plant, has started a study on large-scale acceptance in the Tsukumi plant in Oita Prefecture (2001).
	Waste asphalt concrete	Heated asphalt road repairer	Green Arm	Is developing equipment that heats the road surface with a high-temperature heater, digs up the aggregate, and repaves on site to the same standard as new materials. Using a patent with implementation rights bought from a Canadian company.
Others	Construction sludge	Odessa Technos recycling technology	Japan Resoil Association	Construction sludge with high water content is granulated and hardened to a quality suitable for civil engineering materials in a short time, by adding the company's own cement-based hardener and agitating. With an increase in member companies, the processing capability will expand to 1 million tons per year nationwide.
		Mud concentration system	Toda Corp.	Construction sludge is concentrated to a specific gravity of 1.3 or more and transported for fluidization processing soil.
	Plaster boards	Plaster board recycling system	Several	A system for shredding plaster boards, separating paper from plaster components, and re-using the plaster powder as raw material for boards or ground improvement agents. Though mainly using waste from new construction at present, a future issue is whether expansion to demolition waste is possible.

Source: Various media, interviews

In terms of reducing processing costs, technology for mobile equipment is now evolving. This would promote recycling on site at the same time as reducing output by processing on site. In the Diagate plant mentioned above, for example, the demonstration equipment is transportable. Attention is on the efforts of construction machinery manufacturers with respect to this field.

Whether waste concrete is processed on site or transported to a plant depends on the volume (scale) of demolition works, the duration of the works, the distance to the processing plant, the capability of the processing operator, and other circumstances unique to each individual case. Another important factor is the state of the empty land lot after demolition. When concrete buildings are demolished, the dismantling of foundations creates large holes that cannot be re-filled sufficiently with the available soil. As stated above, this would represent the first receptor of waste concrete, used for this purpose after being crushed to a particle size that conforms to criteria set by the Ministry of Land, Infrastructure and Transport (RC30 or less). In other words, this portion would not be included in the output volume. However, the generated waste concrete cannot always be completely processed in this way, particularly in the case of high-rise buildings, from which large quantities of waste concrete have to be removed from the site. As methods of processing after output, three formats are generally considered: (1) entrust intermediate processing to a nearby plant, (2) transport the waste concrete to another works site that needs it (crushed either on site or at the destination), and (3) process it on site and sell it as merchandise (such as RC40 recycled basecourse materials). While each of these has its pros and cons, if we concentrate on the largest cost factor, i.e. the transportation cost, and the issue of reducing the accompanying social costs, on-site processing could be seen as a persuasive option.[14]

The construction machinery industry is currently reinforcing new technical innovations and seeds in areas such as mobile crushers, with an eye on a future expansion of recycling markets.[15] Their future moves are the subject of much attention.

(2) Processing of waste construction timber

From the perspective of quality, waste construction timber is often inherently difficult to recycle because it has been treated with preservatives, insecticides, and so on. Therefore, as noted above, much of it is incinerated, and future trends are unclear. Nevertheless, various technological seeds have been presented with a view to expanding its marketability. In addition to reuse in laminated boards and paper-making materials, already underway for some higher-quality timber, recently there have been new developments for use as a reducing agent, in power generation, or as cement-firing fuel, which are suited to bulk processing. The background to this could be said to be that, since timber is a carbon neutral material, it is easier to positively evaluate its thermal recycle than that of other materials.

For example, NKK, featured in Table 2-3, is turning its attention to bulk recycling of low-grade timber from the two perspectives of biomass power generation using CFB boilers,[16] and its use as a reducing agent for blast furnaces.

CFB boilers have the advantage of being

[14] Since in this case the demolition operators would themselves take care of intermediate processing, they would also bear responsibility for noise pollution measures, vibration control measures, and other considerations towards the surrounding locality. It would therefore be important to achieve a balance with this.

[15] There has been some debate as to whether self-propelling crusher facilities come under the definition of industrial waste processing facilities. The conclusion is that this is not so when they are used by general construction and other operators. Therefore, when intermediate processors operate self-propelling crushers as their business they need to have installation permission under the Waste Disposal Law. The market for this sector is thought to mainly involve rental and lease to general construction companies, etc.

[16] Circulating fluidized bed (CFB) boilers are a type of fluidized bed combustion in which combustion particles are fluidized by combustible air. In terms of the different forms of fluidity of the combustion particles, they can be broadly divided into stoker combustion, fluidized bed combustion, and pulverized coal combustion. Of these, stoker combustion has its emphasis in the incineration process, as exemplified by the stoker furnace used for incinerating waste. Pulverized coal combustion, conversely, is based in power generation, as used in industrial thermal power generation. Fluidized bed combustion lies in between the two, and is said to be suited to waste power generation (incineration + power generation). In 1991, NKK entered a technical tie-up with the German company Steinmüller, and is now manufacturing and selling these boilers.

compatible with a large range of fuels. As well as soft coal and lignite (brown coal), they can handle low-grade smokeless coal, semi-smokeless coal, biomass of various kinds (peat, bark, wood scrap), oils, and even sludge. With assistance from the Forestry Agency, NKK has been pursuing the development of an optimal recovery and processing system for CCA timber [17] via recycling and combustion in the Hirabayashi district of Osaka since fiscal 2000. The company claims to have confirmed the commercial feasibility of the operation, at least in large urban areas.

For blasting into blast furnaces, waste construction timber is first roughly shredded, then more finely shredded (to less than 10mm) and used as a reducing agent. The company already has a healthy track record with used plastic for this purpose, following the legislation on containers, packaging, etc. For that very reason, it is planning to introduce hybridization, with used construction-type plastics shredded and the PVC removed, in addition to waste construction timber. Demonstrations currently in progress take up the issues of (1) establishing wood shredding technology, (2) establishing hybrid granulation technology, (3) establishing airflow transportation technology, (4) elucidating the tuyere-end behaviour of wood, and (5) confirming the effects on blast furnace operation and the stability of blasting. At the same time, the company is planning to confirm problems on the quality side, including converting CCA timber to slag and detoxifying it, the complete decomposition of insecticides and other substances at a high-temperature reduced atmosphere of 2,400°C, and so on.

Whatever the case, this is expected to open up the way to bulk processing of low-grade timber, whose marketability has been poor until now. However, for this technology to be utilized, the ultimate task will be to guarantee a stable supply. Also, in terms of marketability, we cannot ignore the fact that waste construction timber differs from waste concrete, in that the users of recycled timber are not limited to the construction industry but cross a broad spectrum. Mismatches in supply and demand could, therefore, easily arise from an uneven distribution of information. If information mediation functions can be strengthened with a view to solving such mismatches, as in the case of Komatsu, effects may be expected in terms of both expanding markets and cutting costs.

Closely related to this guarantee of volume is the trend towards cost shrinkage. As with waste concrete, waste construction timber offers only limited absorption of transportation costs, and cost cutting is mainly a question of how far these costs can be kept down. One approach to this, as in the initiative by Takenaka Corp. shown in Table 2-3, would be a scheme designed to cut distribution costs in collaboration with a logistics concern (mainly upper grade timber). Another, presented by construction machinery manufacturers, is to avoid transportation costs by increasing on-site processing (all grades), as in the case of waste concrete. Much attention is now focussed on what sort of schemes will be presented in future for large-scale recycling such as biomass power generation and the use of timber as a reductant, with a view to securing a stable volume of waste construction timber.

(3) Initiatives by the construction industry

Efforts such as the above are backed by initiatives from the construction industry itself. At present, moves in support of the recycling industry are becoming more lively in terms of both intake and outlets, centering on the leading general construction companies (i.e. the principal contractors). These include rigorous implementation of sorted dismantling (typified by “zero emission” work sites) and an expansion of green purchasing aimed at positive use of recycled resources (Table 2-4). Since much depends on efforts made on-site in curbing the generation and output of construction wastes, there is considerable regional disparity in the level of development of arterial infrastructure, particularly when it comes to medium and small sites. Consequently, a uniform response is difficult and the problem cannot be solved simply by introducing a catch-all scheme. Many companies, in fact, are attempting initiatives on a total corporate scale, such as increasing the use of pre-cut timber, arranging construction materials in units, using

[17] CCA stands for “chrome, copper, and arsenic”, referring to timber materials that contain preservatives, insecticides, and other substances.

blue sheets on all floors, simplifying packaging in agreement with construction material transporters, and other efforts designed to reduce waste generation. Their concentration of efforts in accumulating knowhow and horizontal development aimed at efficient sorting and recycling will surely have significant effects. Shimizu Corp., for example, has created a system whereby data gathered and materials prepared on construction waste in individual manual work at its 2,000 sites throughout Japan to date are electronically networked and formed into databases, which can then be uniformly managed by the Head Office (the “Kantas” system). As of September 2001 the utilization rate was 100%, and this is also contributing to a reduction in the waste generation base unit. Obayashi Corp., meanwhile, has long been promoting efforts to reduce waste. It has introduced a system of “zero emission work sites”, mainly for large-scale projects. Here, the waste generated from construction sites are completely recycled, and the company is gradually expanding the range of projects targetted by the system. The knowhow obtained in the process has been compiled in the form of a “Zero Emissions Manual”, and as well as distributing this to all work sites and aiming for horizontal development, the company says this will also be reflected in “green procurement” in future. Takenaka Corp., which has created the waste timber recycling system mentioned above, introduced a travelling recovery system for its work sites in the Tokyo area from 2001, and is promoting a strengthening of waste sorting in small-scale sites where sorting had previously been slow to develop due to cost factors. This could therefore be called a good example of system improvement through the horizontal development of knowhow.

Table 2-4 Outline of Construction Waste Countermeasures by Leading Generation Construction Companies

	Processing of construction waste (%)				Environmental protection costs (million yen) (of which, waste countermeasures)	Main related initiatives (FY2000)
		Re-cycling	Interme-diate process-ing	Final disposal		
Taisei Corp.	Waste concrete	82	14	4	17,391 (9,959)	• Development of a Life Cycle Cost (LCC) Simulation System • Positive acceptance of service life extension work for existing buildings • Zero emissions at construction sites • Expansion of green procurement
	Waste asphalt concrete	86	11	3		
	Wood scrap	20	73	7		
	Sludge	13	74	13	Component ratio 57.3%	
	Mixed waste	5	76	19		
Shimizu Corp.	Waste concrete	59	34	7	27,409 (15,776)	• Development of a concrete resource circulation system • Development of mud (sludge) volume reduction technology in the mud pressurized shield construction method • Development and introduction of the “Kantas” system for networking between all work sites nationwide • Expansion of green procurement
	Waste asphalt concrete	62	35	3		
	Wood scrap	34	43	23		
	Sludge	4	82	14	Component ratio 57.6%	
	Mixed waste (controlled type)	16	77	7		
Kashima Corp.	Waste concrete	93		7	23,052 (10,663)	• Effective use of waste construction soil via the “Underground Continuous Wall Method for Re-use of Waste construction soil” • Recycling of glass wool (heat insulation material) • Creation of a “Small Lot Sorting and Recovery System” aimed at sorting and recovery of mixed waste in the metropolitan and Kansai regions
	Waste asphalt concrete	96		4		
	Wood scrap	89		11		
	Sludge	72		28	Component ratio 46.3%	
	Mixed waste (controlled type)	46		54		
Obayashi Corp.	Waste concrete	9	1	5	24,765 (14,504)	• Zero emissions at construction sites (4 sites in Tokyo and Kansai) • Preparation and distribution of Zero Emissions Manual • Expansion of green procurement • Development of a chemical ingredient database for construction materials
	Waste asphalt concrete	96	1	3		
	Wood scrap	59	28	13		
	Sludge	47	32	21	Component ratio 58.6%	
	Mixed waste (controlled type)	42	10	48		

Note: The level of processing does not permit simple comparison as each company uses different definitions, etc. Environmental protection costs are taken from each company’s environmental account for fiscal 2000.

Source: Prepared from each company’s environment report

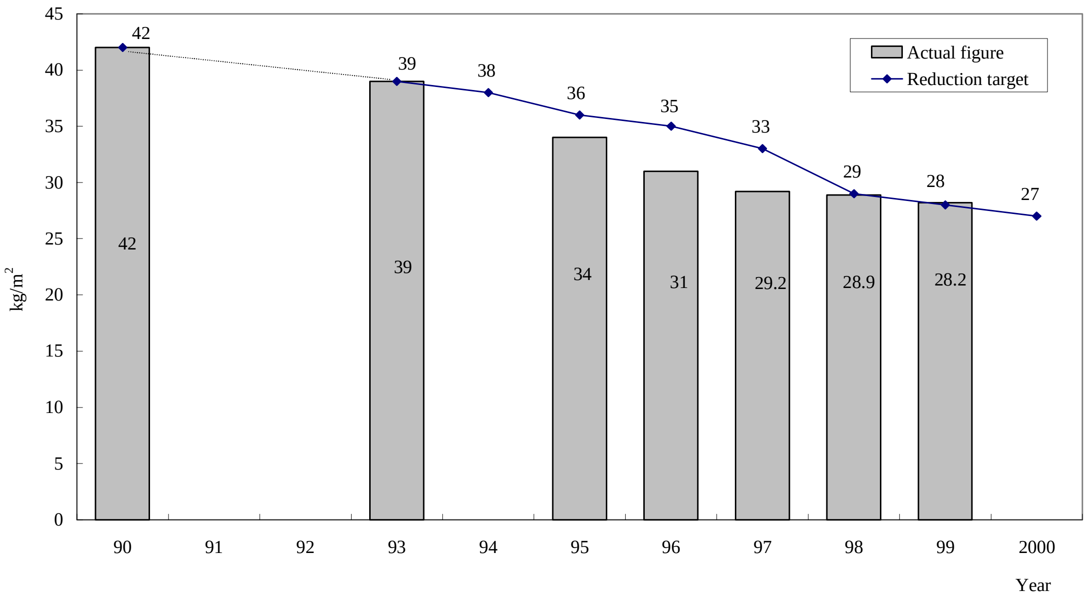


Fig. 2-16 Targets and Actual Figures for Reduction of Mixed Waste Base Units

Source: Building Contractors Society, "Survey Report on Base Units for Construction-Type Mixed Waste"

Behind these initiatives lies the weight of waste countermeasure costs within each company's environmental protection costs. These efforts are becoming more and more advanced each year, as they are linked to the incentive of reducing costs (for example, see the mixed construction waste generation base unit survey in Fig. 2-16). This, through reciprocal effects with the various technology seeds seen above, is expected to encourage an upgrading of construction waste recycling projects.

2.4 Policy Tasks

From the angle of government policy, a response that laterally reinforces these moves is to be desired. The Green Purchasing Law and other legislation enacted around the time of the Construction Materials Recycling Act has fuelled expectations of a market expansion for recycled resources via public works. In fact, the basic principles of the Construction Materials Recycling Act set out a policy whereby projects under direct public control would take the initiative in using resources recycled from specific construction materials. In these basic principles, while economy is regarded as secondary when using these resources in works directly in the public domain, it is of course a basic condition that the quality and other requirements demanded for each usage must be taken into consideration. So now quality control comes into question. As mentioned briefly in the foregoing, current quality standards do not in themselves assume recycled resources, and corrective measures are needed in this respect. Under the amendment to the Building Standards Law (Article 37-1 and 2 of that Law), the materials used in the foundations, main structure, and other parts of buildings ("designated building materials") are to be stipulated by the Minister for Land, Infrastructure and Transport. Of these, concrete may not be used unless it complies with JIS A5308 (Ready Mixed Concrete). These JIS standards assume gravel and sand to be natural resources and crushed stone and crushed sand to be taken from natural rock. Recycled resources are not included. When using concrete that does not comply with JIS, the Building Standards Law requires individual authorization by the Minister. In demonstration tests conducted so far on structural concrete using recycled resources, this individual authorization has been obtained even though the performance satisfies the JIS standards. While these procedures can be expected to improve with application, if we are to positively promote the use of recycled resources, we surely need to develop quality standards that assume the use of recycled materials. A major overhaul of the JIS system is now in progress, and, as one aspect of this, the Ministry of Economy, Trade and Industry has reportedly started studies on environmental JIS that would cover the environmental sector laterally.[18] Developments of this sort could be expected to bring improvements to such points as well. Taking the example of waste concrete, it is beyond doubt that marketability will be hugely improved once quality standards have finally been arranged to suit the various stages (high-level recycled aggregate for use in architectural structures, medium-level recycled aggregate for use in foundations and other works, and cascade recycled aggregate for basecourse and re-fill, and other materials) and public works procurement is conducted positively in line with this.

More problems arise because it is not known, until the demolition phase, to which level the use of recycled aggregate is suited. While technology seeds for recycling concrete and re-using it as a structural material are now being established, as mentioned above, not all demolished structures are covered.[19] Since these are buildings for use in human activity, every attention has to be paid to guaranteeing reliability. Only aggregate that clears careful scrutiny of saline concentration, particle size distribution of coarse and fine aggregate, and so on, can be used for horizontal material recycling. Test pieces have to be sampled from the core of a building prior to demolition, and these have to be tested in advance for alkali aggregate reaction and saline content ratio. This determines whether or not the aggregate can be re-used. While the quality of this aggregate can basically be inferred, to a certain extent, from the year in which the building was built, when actually examining a building it is said that the quality is not necessarily better if the building is older. Considerable effects could be yielded by developing databases, for example by taking samples of aggregate whenever an existing building undergoes renovation or similar work and specifying the recycling level in advance. Policy initiatives are also to be expected in this respect. For the time being, a variety of systems (for example, concrete diagnosticians) have been developed to meet the arrival of the maintenance era. It would probably be effective if the functions of gathering these kinds of quality data could be included as one aspect of this.

3. Problems Concerning Waste Construction Soil

3.1 Problems with Waste Construction Soil

So far, we have outlined the impact on the construction recycling industry with principal focus on materials targetted by the Construction Materials Recycling Act. Another issue to consider is waste construction soil, which is forecast to change dramatically in future. As also seen above, waste construction soil accounts for the greatest weight in the output of construction wastes. As such, an increase in output is anticipated, with the oncoming renewal of social infrastructure in future (Fig. 1-16). Waste construction soil has until now been distributed as a commodity, mainly for inland use when elevating farmland or housing land, filling valleys, and so on. With the recent advance of information technology, trading between construction sites has also become more efficient, and for this and other reasons waste construction soil is not treated as directly contentious by the Construction Materials Recycling Act. However, with a separately ongoing debate for legislation to cover soil pollution countermeasures, this is highly likely to have a major impact on construction recycling trends.

Specifically, there are fears that, by creating an obligation to take measures against soil pollution, the proportion of waste construction soil disposed of as polluted soil will increase with advances in pollution surveys and identifica-

[18] In January 2002, a Working Group was set up in the Select Committee on Environment and Resource Recycling in the Japanese Industrial Standards Committee.

[19] At present, the aggregate recovered from buildings that have reached demolition age is said to be superior in many cases, mainly consisting of river gravel, but the proportion of aggregate that can be used in architectural structures is said to decrease as the age progresses.

tion.[20] Unpolluted soil will probably continue to be processed through inland acceptance and trading between construction sites as a negotiable commodity. However, as the identification of polluted soil advances, the final disposal volume from the construction industry will increase, and, in the worst case, there is an undeniable possibility that it could cancel out the effects of reduction of final disposal volumes due to recycling of waste concrete and other construction wastes. Moreover, pollution fears could stir up concern over the quality of all waste construction soil, and this could hinder the efficiency of distribution. Waste construction soil has the potential to indirectly exert a huge impact on trends in the Construction Materials Recycling Act, triggered by these problems of soil pollution. To avoid this kind of situation, instead of transporting contaminated soil to landfill sites, it should be purified and then re-buried, or used in other sites, and thus lead to the recycling of soil.

3.2 Characteristics of the Environmental Remediation Industry

Normally, the following points are made in connection with the problem of soil pollution. (1) The transportation, dispersion and dilution of substances are incomparably slower than those in the atmosphere or surface water, and, in addition to “end-of-pipe” measures against pollution sources, purification and stabilization processes are required (stock-type pollution). (2) Furthermore, it takes a long time before input pollutants become manifest as problems, and the relationships of responsibility are often ambiguous in the meantime. Also, since the soil beneath land owned by individuals or corporations is affected, rules to adjust complex relationships of rights and liabilities would be needed before countermeasures could actually be attempted. In many western countries, in fact, attempts have been made to address this problem with legislation for soil protection since the 1980’s. In Japan’s case, however, countermeasures have been limited to specific exposed channels such as groundwater or farmland, and no legal provisions exist to cover the geological environment as a whole. Consequently, progress in real measures against this problem is said to be slow. In the meantime, with progressive changes in the industrial structure and an increasing pressure towards securitization of real estate (mainly land that was once used by manufacturing industries), there is now a common perception that the risk of soil pollution forms a major obstacle to the conversion of land use. Behind this lies the common knowledge that legal provisions are about to be introduced for comprehensive measures against soil pollution, a move which has been pending for many years.

As to the industry responsible for soil pollution countermeasures (which we will call “the environmental remediation industry”), several calculations have already been made on the scale of the latent market that is predicted to surface as legislation for soil pollution countermeasures takes shape. In every case, they indicate a colossal market scale.[21] Corporate activity in this sector started in earnest in the second half of the 1980’s. The main protagonists were large corporations with main business interests in areas such as construction, engineering manufacturing, and non-ferrous metal refining. These were mainly companies with financial and technical strength. They started by introducing technology from pioneering companies in western countries, but their technical level is said to have already reached that of the west in just over 10 years since then.

On the other hand, the environmental remediation market that provides a stage for corporate activities is of a special type that does not easily permit comparison. Since there are no legal pro-

[20] It is already rapidly becoming the norm for owners to carry out pollution surveys before starting new construction works, in response to the ongoing development of frameworks for soil pollution countermeasures by local authorities in a form that pre-empts national regulation (as seen in the environmental guarantee ordinances issued by the Tokyo metropolitan government). Therefore, we may see this kind of tendency as already gaining strength.

[21] For a hypothesis on the profile and market scale of the environmental remediation industry, see Takegahara (1999). It should be borne in mind that this type of calculation has its limitations. For example, (1) calculations are based on the present form of land use, therefore land owned by industries without risk of soil pollution (e.g. the service industry) is not considered and the calculation errs on the conservative side. Or (2) the estimates are too high as they assume processing costs under the current circumstances of incomplete competition. Nevertheless, we feel that they are significant in estimating magnitude.

visions, the majority of soil pollution countermeasures to date have been implemented independently by large corporations pressed by necessity. Despite their "independent" nature, once pollution comes to light there is a great risk that a company will be exposed to harsh social criticism and its corporate image impaired, as many past examples show. Therefore, information on soil pollution countermeasures is rigorously controlled, and renewal contracts have become centred on cross trading. These market characteristics have also affected the format of environmental remediation companies. In order to win the reliance of orderers concerned about information management, the full-line format (one-stop shop) has become the norm, creating a system of technology whereby one company can handle all kinds of pollution. Since the technology involved in environmental remediation crosses a broad spectrum, covering all of it imposes a huge burden on companies. So far, the environmental remediation market in Japan has had low potential for advance comparison from the user's point of view. From the provider's point of view, meanwhile, it entails a high burden of research and development, etc., compared to the relatively small absolute number of cases. This can therefore be described as a special domain.

3.3 Changes due to the Introduction of Legislation

The introduction of legal provisions for measures against soil pollution will bring major changes to these characteristics. In reality, we still await detailed system design and operational trends.[22] Nevertheless, as a general trend, it is thought that demand will increase due to the obligation for soil pollution surveys and purification and the introduction of inventory management for polluted land by local authorities and others. Due to the reduced anonymity of information, meanwhile, competitive principles will become more mobile and downward pressure on prices will start to mount.

Increased demand involves the dual aspects of expansion of the client base and increased processing volume via substitution for final disposal. Since surveys and purification measures have been made obligatory under certain conditions, the client base is expected to expand vastly, for a number of reasons. For example, (1) implementing bodies will expand from the independent action taken by large corporations to a broader range including core companies and small and medium enterprises, while at the same time (2) the range of interested parties (other than those under legal obligation to purify) pressed by the need to evaluate the risk of soil pollution will also increase greatly. In one sense, the survey and evaluation process is expected to greatly enlarge the broad base, mainly concerning the needs of companies that have not paid great attention to this problem in the past, the real estate valuation industry and financial institutions that have conventionally evaluated real estate values without attention to the risk of soil pollution, and others.[23]

Substitution for final disposal means that the relative precedence of remediation processes over final disposal will increase because, even if attempting to transport contaminated soil off site for landfill, acceptance destinations will become even more difficult to secure and disposal costs will rise even higher. These, in turn, are because the absolute volume of polluted earth will increase while no improvement can be foreseen in the tight situation of landfill sites.

The expanding demand for remediation is expected, in one sense, to increase the need for purification (re-filling, transportation and re-use after purification) on-site not accompanied by transportation costs. However, on-site processing involves many elements of uncertainty, such as the constraints on land use if the construction period becomes protracted, problems of purified soil for outward transportation (i.e. whether or not an acceptance destination can be found, transportation costs), and so on. Therefore, com-

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[22] For the state of studies at present, see "Directions for a System of Soil Environment Protection Measures (Interim Report)" (September 2001) by the Study Group on Directions for a System of Soil Environment Protection Measures, Ministry of the Environment.

[23] Efforts to promote the upgrading of due diligence services (such as quantified evaluation of soil pollution risks) in response to this demand include the Land Solution company established with capital from Kurita Water Industries Ltd., Dowa Mining Co., Ltd., and others.

petition to develop technology for reducing costs and shortening construction periods will probably progress in future. Various new methods have been proposed by renewal companies in this respect. In particular, the mobile mixers introduced by construction machinery manufacturers for soil improvement are receiving attention as tools that go beyond their initially assumed purpose and can be used efficiently against contaminated soil on site (i.e. mixing of chemical agents). Instances of technology exchange and fusion with the construction recycling sector have been seen (for example, improved mixing levels in response to requests from remediation companies), and further advances are expected. In the offsite processing sector (i.e. processing after transportation to dedicated plants), meanwhile, companies that can use existing equipment and knowhow, mainly in non-ferrous metal refining, and can absorb purified soil on their own premises have always had a competitive advantage. Depending on the region, these are expected to absorb a considerable part of the substitution for final disposal. The problem with offsite processing is its transportation costs. It is hoped that a more efficient system will be presented in future, for example through tie-ups with logistics concerns, as seen in construction recycling.

Whatever the case, the environmental remediation industry following the introduction of legal provisions will face a harsh business environment in which, while the demand volume expands, greater cost effectiveness will be demanded than in the past. Given this business environment, the full-line business model, in which even processing technology bearing little relation to the company's own competence must be fully internalized, would be difficult to maintain in terms of cost competitiveness. In future, one would expect to see more tie-ups between remediation companies that are capable of complementing each other.

Many of the protagonists in this remediation business, most notably general construction companies, are the same as those involved in construction recycling. In this sense, the environmental remediation business could be seen as an important element of construction recycling in the broad sense, and positive efforts to this end are expected from all companies.

In terms of policy, as was also mentioned in the report by the Ministry of the Environment's Study Group, support measures will need to be developed and enhanced in line with changes accompanying the introduction of regulations. This could include granting financial incentives to companies newly burdened with legal obligations. If, for example, a tax allowance system could be introduced not only for small and medium enterprises that are barely able to accept new financial burdens but also for large corporations, it could have the effect of guaranteeing the efficacy of construction recycling through the stimulation of the environmental remediation business. Meanwhile, action on quality control is also to be desired, enabling soil that has been purified – whether on or off site – to be distributed in the same way as unpolluted excavated earth.

III Developments Aimed at Prolonging Service Life

Japan is now approaching a period of renewal of buildings and social infrastructure that were developed in the era of rapid growth, and there are fears of an unprecedented expansion of construction waste accompanying this. As a result, Japan has created a system of construction recycling ahead of other countries. In future, to achieve further progress in technical development aimed at efficient recycling as we have seen until now, backing from government policy will surely become even more important to efficiently promoting urban renewal projects. At the same time, slowing the pace at which existing buildings and structures reach their demolition phase is an equally important task. In this sense, efforts aimed at prolonging service life, an issue of increasing concern today, could be seen as having a major influence on our prediction of future developments involving construction waste.

1. Moves to Prolong Service Life

Now that the perspective of life cycle assessment (LCA) has become commonplace, there is a widening perception that conventional construction works, featuring repeated cycles of scrap-and-build over short periods, are not good for the environment. This, together with other background factors such as the current deterioration of fiscal finances, has brought the issue of prolonging the service life of buildings and structures to the fore as a major social requirement recently.

Prolonging the service life of buildings and structures means shortening the gap between the service life naturally expected of these in terms of their structure (the expected value) and the actual service life. For new construction works it is thought to be achieved by introducing new technology to guarantee service life over the long term, and for existing buildings by applying appropriate maintenance and thus extending the usable time span as far as possible. Although the importance of prolonging service life had previously been pointed out, it has been slow to materialize in Japan compared to western countries, and has now been highlighted as a problem.

Factors governing this prolongation are said to be broadly divisible into two types, namely those of installation and maintenance, i.e. technology, and those not falling under this description.[24] In other words, to consider the reasons for the tardiness in this area, we may first divide them into inadequacy of technical capabilities and the impact of other factors. A variety of factors have been pointed out as not falling under the description of technology. For example, the fact that the emphasis is on land and that the value of buildings has been underestimated, a mentality derived from climate and customary usage, the sovereignty of personal ownership rights, or the fact that scenery and urban landscapes are not regarded as social assets, and so on. However, the biggest of all is probably the fact that obsolescence in terms of functions has advanced more quickly than anticipated. The environment surrounding buildings and structures is gradually changing, as witnessed by the advance of population aging, the strengthening of disaster prevention or energy saving policies, and so on. Often, the requirements accompanying this are also changing greatly. In particular, there must be some requirements associated with environmental changes that were not even imagined when these buildings were first constructed. Recently, it has been said that the advance of the IT revolution (for example, adequate floor height for LAN wiring) has caused a rapid obsolescence of the functions of existing buildings and structures.

As for technology aimed at prolonging service life, various seeds are already at the commercial stage. These include some that may be expected to have a major effect on the entire problem of cities and the environment, such as preventing heat islands and improving scenery through rooftop garden technology. The way in which these are diffused in future holds the potential to greatly further the service life extension of buildings and structures in Japan. Meanwhile, sure progress is being made in developing service systems to link these technologies to actual needs, as in the establishment of special units in response to the renewal market in general construction companies and many other firms.

[24] See Hayashi (2001) and others (References).

Viewed in these terms, the problems of prolonged service life in Japan may be sought exclusively in elements other than technology.

2. Changes in the Economic Climate and the Development of Policies

As mentioned above, elements other than technology are many and various. While no measures could possibly embrace them all, policies designed to remove obstacles are now being developed. One isolated example could be trends in the housing market. The Action Plan for Improving the Housing Market, drawn up by the Ministry of Land, Infrastructure and Transport in August 2001, cites the development of a trading market for second-hand housing as a priority task. This reveals that the focus of housing policy is shifting from the stimulation of demand for new construction to expansion of the second-hand market. The scale of the second-hand housing market in Japan is tiny compared to those in the west. It is said that a lot of second-hand housing is demolished, regardless of its structural life cycle, when no buyer can be found. The Action Plan indicates a trend towards promoting the creation of schemes that aim to solve asymmetry of information, which hinders trading in second-hand housing, by introducing systems of performance indicators and price appraisal for second-hand housing. On the private-sector side, meanwhile, the supply of low-cost home improvement services is increasing in response to these trends. In the housing market, in which housing is often thought to lose its value after around 15 years, it has been pointed out that many issues, such as taxation, remain to be addressed before the second-hand market can be activated. Nevertheless, with the focus of policy shifting from flow to stock, this is also expected to have an effect on prolonging average life cycles in the housing sector in future, hand in hand with demands for suitable burdens of demolition costs under the Construction Materials Recycling Act.

Similarly, the development of a basis for identifying the characteristics of existing stock and maintaining it appropriately is being promoted (for example, the issue of Standard Specifications for Concrete Structure Maintenance Work by the Japan Society of Civil Engineers, or the creation of “concrete diagnosticians”, a system of qualifications for diagnosis and maintenance of concrete structures by the Japan Concrete Institute). This is also expected to contribute to the removal of obstacles other than technical elements with a view to prolonging service life in future. On the obsolescence of functions, thought to be the biggest problem of all, meanwhile, many companies that supply technology for prolonging service life not only offer life extension works for building frames, but are also turning to the provision of comprehensive engineering services as well. Thus, with the increasing sophistication of these services, suitable sections that can be corrected through appropriate renovation work are expected to be covered. In terms of the relationship with construction recycling, if the process of reinforcing maintenance of existing stock could lead to a system for managing their characteristics in the form of a database, it would also contribute to an understanding of the long-term output volume of recycled materials at all levels, from re-use in architectural structures to use in basecourse materials. It should also provide an opportunity for further increasing the efficiency of recycling systems.

3. Conclusion

As moves become more lively in search of a new urban image for the next generation in Japan, as exemplified by urban renewal projects, this survey has attempted to approach the problem of urban reconstruction from the perspective of resource recycling. Both buildings and social infrastructure stock are approaching the renewal phase for stock that was accumulated rapidly up to the first half of the 1970’s. If renewal prceeds to the optimal state of inventory-taking with a view to building a new urban image, there is an undeniable possibility that the output of construction waste will increase at a pace not experienced before. Therefore, a response from both the policy side and industry is important in order to prevent this problem from becoming a bottleneck for urban renewal. As already seen, Japan has constructed a new framework for construction recycling in advance of other countries, while a succession of various technological seeds and business models are being created by industry in line with this. Among others, system improvements are expected to develop at various levels in future to ensure that these efforts by public and private sectors yield reciprocal effects.

An example of this is the achievement of consistency between the problem of quality control, whereon hangs the expansion of marketability for recycled materials, and that of soil pollution, now subject to ongoing debate.

While measures for recycling are promoted, various public and private sector initiatives aimed at prolonging service life lead to expectations that the scenario of rapid increase of construction waste can be eased somewhat, and future progress is to be expected in this respect. As an exercise, Fig. 3-1 shows what would happen if the demolition probability rate were changed from building starts in fiscal 2000 (i.e. the peak years for generation of waste were extended), based on the assumption that the conditions for calculation in 1 above are changed and progress is seen in prolonging the service life of buildings and structures. It is to be hoped that this prolongation of service life, together with the development of recycling infrastructure, will serve to prevent the problem of resources recycling from creating bottlenecks in urban renewal.

Now, a policy framework to regulate future trends is being developed. The Construction Materials Recycling Act has become law, and studies on legal provisions for soil protection are in progress. It could be seen as desirable that a consistent policy framework should be created and developed, partly with a view to utilizing the various technological innovations of the private sector that are being developed on the above basis.

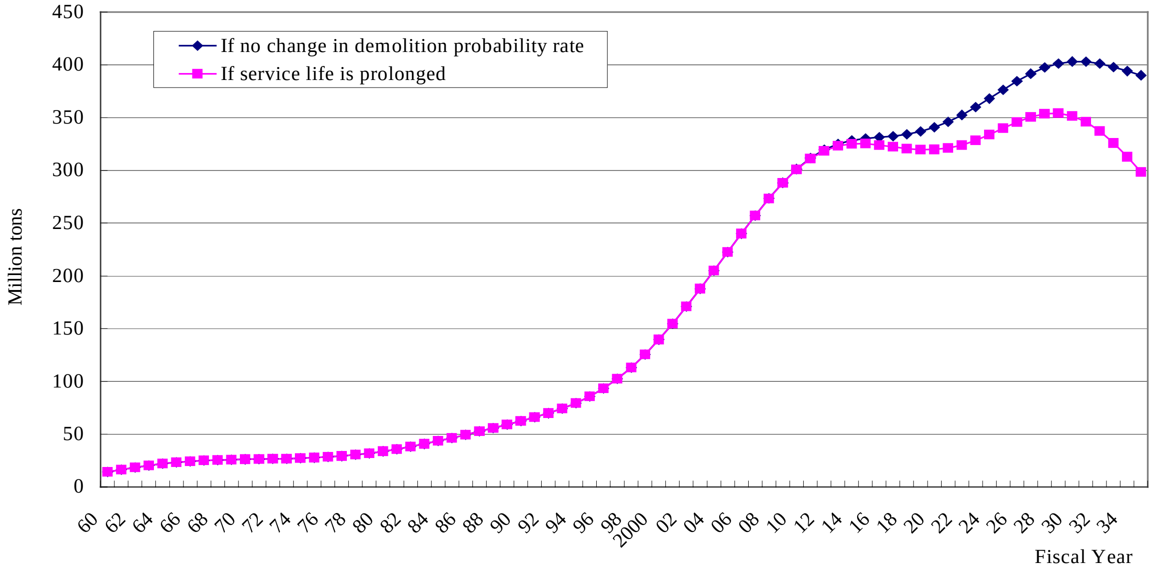

Fig. 3-1 Reduced Generation of by-Products (excluding waste construction soil) through Extension of Service Life

Note: Calculations assume that the “no change in demolition probability rate” assumed in 1 above is changed, steps are taken to prolong the service life of buildings and structures, the demolition probability rate is amended from building starts in fiscal 2000, and the peak waste years are extended for timber buildings (from 33 to 40 years), non-timber buildings (from 40 to 50 years), and public and private sector civil engineering works (10 years added to the estimated service life in each case).

Source: DBJ calculations

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