An integrated approach: managing resources for post-disaster reconstruction

Yan Chang¹, Suzanne Wilkinson², David Brunsdon³, Erica Seville⁴, Regan Potangaroa⁵

Abstract

A lack of resources required for post-disaster housing reconstruction significantly limits the degree to which a successful recovery can occur. In the aftermath of the 2008 Wenchuan earthquake in China, the post-quake reconstruction of housing was not immune to resource shortages and price inflation. This paper illustrates evidence of resourcing bottlenecks during the post-Wenchuan earthquake reconstruction. The aim of this paper is to present an integrated planning framework required to manage resources for post-disaster housing rebuilding. The results are drawn from in-field surveys which highlight the areas where stakeholders need to concentrate effort, including revising legislation and policy, enhancing capacity for rebuilding in the construction industry, strengthening the transportation network, restructuring the market mechanisms, and incorporating environmental considerations into the overall planning.

¹ PhD candidate, the Department of Civil and Environmental Engineering, the University of Auckland
² Associate Professor, the Department of Civil and Environmental Engineering, the University of Auckland
³ Director, Kestrel Group, New Zealand
⁴ Science Leader, Resilient Organisations Research Programme
⁵ Associate Professor, School of Architecture, Unitec, Auckland
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I. Introduction

In comparison with pre-event project construction, the post-disaster reconstruction environment is chaotic, dynamic, and complex (Berke et al., 1993; Alexander, 2004; Birkland, 2006; Davidson et al., 2007). After a large-scale disaster, housing reconstruction projects are susceptible to numerous resource bottlenecks inherent in post-disaster circumstances, such as lack of suitable resources and alternatives (Russell, 2005; Zuo and Wilkinson, 2008), disruption of access to available resources (Green et al., 2007) and limited ways of procuring resources (Brunsdon et al., 1996; Oxfam Australia et al., 2007), which significantly impede the reconstruction process in disaster-affected countries. If combined with an ineffective resourcing approach (UNDP, 2005; IFRC, 2006) and poor resource management (Steinberg, 2007), the resource environment becomes one of project failure and rework (Steinberg, 2007), ‘Dutch disease’ (Corden, 1984; Adam and Bevan, 2004), and ‘cost surge’ (Rodriguez et al., 2007; Jayasuriya and McCawley, 2008) which undermines the effectiveness of post-disaster reconstruction performance.

Evidence of resource management for disaster recovery probably can be found in previous case studies. For instance, during the post-Indian Ocean tsunami reconstruction, the government in impacted areas encouraged the use of environment-friendly, low cost and seismically resistant materials by providing relevant preferential policies (Boen, 2006; Barenstein and Pittet, 2007; Steinberg, 2007). Nevertheless, recommendations on new construction methods and materials...
were not popular or accepted by some local traditions and customs (Schilderman, 2004; Boen and Jigyasu, 2005). A lack of understanding of these advanced products and techniques hindered their wide use and application in affected areas (Steinberg, 2007; Roseberry, 2008).

Conventional measures have been employed in the past practice to address the resourcing problems, such as regulating the market to stem post-disaster inflation (Jayasuriya and McCawley, 2008), importing resources from overseas (Zuo and Wilkinson, 2008), and reallocating funds from existing projects to meet recovery needs (Freeman, 2004). Last-minute improvisations at the operational level seem to be unable to perform well to alleviate resource shortages in the long run (Jayasuriya and McCawley, 2008). In addition, the absence of pre-event planning and preparedness (Alexander, 2004; Orabi et al., 2009), the inadequacy of efficient and flexible institutional arrangements (Sullivan, 2003), and the lack of pro-active engagement of the construction industry into disaster management (Lorch, 2005; Pheng et al., 2006; Bosher et al., 2007) are also underlying contributors to vitiating resource procurement in a post-disaster environment.

Based on the empirical analysis of the Wenchuan earthquake rebuilding experience, this paper provides solutions to post-disaster reconstruction resource availability and management, showing alternative planning and preparedness strategies for managing resources in a post-disaster environment. An overview of housing reconstruction with respect to resourcing after China’s Wenchuan earthquake is presented. The paper tackles the following key questions:

(1) What are the constraints in a post-disaster resourcing environment? and

(2) What needs to be addressed to improve resourcing management for housing rebuilding projects after a disaster?
The paper further proposes a conceptual planning framework for recovery practitioners in China to understand the key areas they need to attend to in arriving at a satisfactory level of post-disaster resource management. The impacts of the Wenchuan earthquake and the related lessons and experiences are expected to influence the way international practitioners deal with disaster reconstruction, such as promoting a process which enables shared responsibility for resource management. Although the focus is on the perceptions, practices and perspectives in China’s context, this study draws attention to the vulnerable areas commonly facing the international community in the aspects of resourcing for post-disaster housing reconstruction projects.

II. Earthquake impacts on housing in China

On 12 May 2008 the magnitude (M) 8.0\textsuperscript{1} earthquake struck China’s province of Sichuan and its neighbours. The Wenchuan earthquake, as it is commonly known, killed 69,266 people, injured 374,643 people and left 17,923 people missing\textsuperscript{2}. The earthquake caused widespread destruction to buildings and infrastructure. The epicentre was in Wenchuan County, a rural and mountainous region in Sichuan Province, around 50 miles (80 kilometres) from capital city Chengdu. More than 15 million housing units collapsed during the earthquake and resulted in direct losses to buildings and infrastructure of over US$150 billion (Paterson et al., 2008). Approximately 34,125 kilometres of highways, 1,263 reservoirs, 7,444 schools, 11,028 medical institutions and numerous urban, rural residences and factories were devastated by the earthquake with direct economic losses reaching US$123.66 billion (State Planning Group, 2008). In this earthquake, housing was the single greatest component of all losses in terms of economic value and in terms of building damaged.
The damage experienced by structures in the Wenchuan earthquake was largely contingent on the construction type. In the mountainous terrain of Sichuan Province, most of housing buildings were one or two story masonry structures composed of bricks or concrete blocks that did not possess seismic-resistant elements. These structural defects made housing highly vulnerable to earthquakes, and consequently, many collapsed. For instance, in the impacted towns and cities at the foothills of the mountains on the edge of the Chengdu plain, such as Dujiangyan, Mianzhu, Pengzhou, and Shifang, the majority of buildings were not properly designed nor built with sufficient provision to withstand earthquake shaking, thus suffered varying degrees of damage. Table 1 and Table 2 show the scale of housing reconstruction required in the earthquake impacted region.

**Table 1** Rural housing retrofit and reconstruction household units

<table>
<thead>
<tr>
<th>Strengthening</th>
<th>Unit</th>
<th>Total</th>
<th>Sichuan</th>
<th>Gansu</th>
<th>Shaanxi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household (1,000)</td>
<td>2141.1</td>
<td>1904.2</td>
<td>125.5</td>
<td>111.4</td>
<td></td>
</tr>
<tr>
<td>New construction</td>
<td>Household (1,000)</td>
<td>3289.7</td>
<td>2984.9</td>
<td>260.4</td>
<td>44.4</td>
</tr>
</tbody>
</table>

Source: Adapted from (State Planning Group of Post-Wenchuan Earthquake Restoration and Reconstruction, 2008)

**Table 2** Urban housing retrofit and reconstruction area

<table>
<thead>
<tr>
<th>Strengthening</th>
<th>Unit</th>
<th>Total</th>
<th>Sichuan</th>
<th>Gansu</th>
<th>Shaanxi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (1,000 sq. m.)</td>
<td>58,070.9</td>
<td>55,177</td>
<td>2,204.7</td>
<td>689.2</td>
<td></td>
</tr>
<tr>
<td>New construction</td>
<td>Area (1,000 sq. m.)</td>
<td>66,201</td>
<td>64,900.3</td>
<td>98.5</td>
<td>315.7</td>
</tr>
</tbody>
</table>

Source: Adapted from (State Planning Group of Post-Wenchuan Earthquake Restoration and Reconstruction, 2008)
III. Housing reconstruction approaches in China

One of the most complex tasks facing recovery managers is to determine and implement the most appropriate ways to reconstruct buildings and infrastructure (IRP, 2007). There is a growing body of literature concerned with the advantages and disadvantages of different approaches to post-disaster housing reconstruction (e.g. (Barakat, 2003; Barenstein, 2006; Twigg, 2006; Barenstein, 2008)). Several elements have to be weighed up when choosing the appropriate reconstruction method, including the wider political and social contexts (Oliver-Smith, 1990), operational requirements (Harvey, 2005), as well as the expectations and preferences of the people affected (Bolin and Stanford, 1998). In addition, rebuilding approaches may also be determined by factors such as the agency’s available resources, overall mandate, experience and capacities (Barenstein, 2006). As Davidson et al. (2007) pointed out, construction in general and reconstruction in particular are rooted in their socio-politico-economic contexts and there is no single best approach for community participation. Within the same disaster context, different agencies/individuals may adopt varied reconstruction methods. Three main reconstruction approaches are widely applied in the past disaster reconstruction practice:

- Contractor-driven approach: external expertise or professional building contractors are engaged to design and build the houses for people affected.
- Donor-driven approach: NGOs or other designated organizations are tasked with housing rebuilding projects for beneficiaries.
- Owner-driven approach: house owners/beneficiaries are responsible for rebuilding their own houses with external financial, technical and material assistance.
Regarding post-disaster reconstruction projects in developing countries, the UNDRO (1982) advocated the community participatory approach/owner-driven approach. There are various ways in which people affected can participate in post-disaster housing reconstruction projects but not all types of participation ensure the best deployment of their capabilities (Davidson et al., 2007). Owner-driven reconstruction does not necessarily imply that owners build the house themselves, but that the owners retain full control over the housing reconstruction process (Barenstein, 2006).

When it comes to the operational project level, Davidson et al. (2007) illustrated, with case studies in Sri Lanka, El Salvador, Colombia and Turkey, that the success of community participation in housing projects lies largely in which stage of construction they are involved in.

In China, four months after the earthquake, The State Overall Planning for Post-Wenchuan Earthquake Restoration and Reconstruction (2008) developed in partnership with all parties involved was released by the National Government of China (NGC) for implementation. The guarantee of people’s well-being was deemed the fundamental issue in post-Wenchuan earthquake restoration and reconstruction, top priority was, therefore, given to repairing and rebuilding the urban and rural residential houses, restoring public facilities and infrastructure to ensure the resettlement, stability and safety of the affected population.

In August 2008, as the housing reconstruction progressed, an owner-driven reconstruction approach with a combination of governmental subsidies, partnership assistance and social help and support was advocated in rural impacted areas. Many examples of local reconstruction planning, land readjustment, joint housing and actual rebuilding participation, show how the people affected leverage their value into collective reconstruction solutions. The challenge found with the community participatory role was in ensuring that new constructions meet building standards and are seismically resistant. Some counties in the affected rural areas in Sichuan
Province adopted innovative approaches, encompassing accessible education and training for farmers not only on the technical specifics of building codes, but on the basic reasoning that underlie them, and linking the provision of subsidies to inspection and monitoring at each stage of the house reconstruction process (Paterson et al., 2008). In contrast, in the urban cities impacted, housing reconstruction projects were mainly carried out by professional building contractors or other social organizations.

Previous literature on post-disaster housing reconstruction shows preference for advocating contextualized community participatory approaches; however, has largely overlooked the role of the construction industry especially the participant builders/contractors approach to reconstruction. This lack of attention is somewhat surprising given the pivotal execution of these construction professionals in terms of the procurement of resources required for housing projects. During the Wenchuan earthquake, the builder/contractor-led resource management was key to the housing reconstruction.

IV. Research methodology

This paper provides an investigation of housing resourcing after the Wenchuan earthquake in a contractor/builder-led reconstruction context. In order to understand the resourcing process for housing projects and answer the questions of (1) and (2), empirical-based qualitative methods were adopted including field interviews. Review of policy documents and media publications was also carried out for this research. The interviews were semi-structured, allowing for open discussion during the interview. The interview sessions were voice recorded, transcribed and coded. Citations and comments made in interviews and presented in the paper were selected as
representative in regard to the specific subjects, and were confirmed and approved by the interviewees.

The interviews were conducted in earthquake-impacted areas in China’s Sichuan Province between December 2008 and February 2009. A varied sample was selected containing:

- 16 construction contractors (coded C1-C16) who have been operating in post-Wenchuan earthquake reconstruction in China, registered with the Construction Bureau of People’s Government of Mianzhu City, China;
- 5 academic researchers (coded R1-R5); and
- 5 local government officials (coded G1-G5) involved in post-Wenchuan earthquake reconstruction.

The selected interviewees were positioned in different specialization areas. The profile of the interviewees is shown in Table 3.

<table>
<thead>
<tr>
<th>Interviewee Code</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td><strong>Specialization</strong></td>
</tr>
<tr>
<td>C1-C4</td>
<td>Construction coordinators</td>
</tr>
<tr>
<td>C5-C8</td>
<td>Project managers</td>
</tr>
<tr>
<td>C9-C16</td>
<td>Resource procurement managers</td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td><strong>Research Area</strong></td>
</tr>
<tr>
<td>R1</td>
<td>Environmental sustainability</td>
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<tr>
<td>R2-R3</td>
<td>Construction material</td>
</tr>
<tr>
<td>R4-R5</td>
<td>Construction procurement</td>
</tr>
<tr>
<td><strong>Group 3</strong></td>
<td><strong>Main Responsibility</strong></td>
</tr>
<tr>
<td>G1</td>
<td>Construction technical advisor</td>
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<tr>
<td>G2</td>
<td>Construction market transaction regulation</td>
</tr>
<tr>
<td>G3-G4</td>
<td>Post-quake reconstruction supervision</td>
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<tr>
<td>G5</td>
<td>Transport planning</td>
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*Table 3: Profile of the interviewees*
During the interviews, qualitative data on perspectives and insights of these 26 participants was captured, including:

- key stakeholders in resourcing for post-disaster reconstruction and their responsibilities;
- underlying constraints pre-existing and post-disaster to resourcing process;
- initiatives that have been taken to improve resource availability for reconstruction projects; and
- likely measures and alternatives to address the resourcing problems.

Sections V-VII of the paper are based on data gathered through field-based observations and interviews. The resourcing practice of post-Wenchuan earthquake housing reconstruction is examined and the resourcing constraints are discussed. The interview findings are used to develop a conceptual planning model presented in Section VIII for improvement of resource management in a post-disaster environment.

V. Retrospection on post-Wenchuan earthquake resourcing

Resource management broadly encompasses a wide range of activities that have a bearing on resource provision for construction projects, embracing resource planning and preparedness, resource procurement, resource delivery, and development of resource alternatives. A desirable resourcing approach calls for an integrated connection with all stakeholders (Voordijk, 2000; Cox and Ireland, 2002; Yeo and Ning, 2002). In a disaster context, this could be accomplished by embracing stakeholders into an adaptive and cooperative process for attaining resources. With this in mind, China’s resourcing practice in the housing sector after the Wenchuan earthquake is reviewed and discussed below.
**Most vulnerable resources**

The Wenchuan earthquake serves as an exemplar for the disproportionate volume between resource demand and supply during the post-quake reconstruction (See Table 4). The supply shortfalls of building materials in Table 4 indicate that the reconstruction demand was sufficient to pose difficulty to reconstruction practitioners in procurement of materials. Labour scarcity was another problem leading to precipitous wage increases undermining the functionality of local construction markets.

**Table 4** Estimated supply shortfalls of cement, brick and steel in earthquake-stricken areas

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<tr>
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<tr>
<td>Cement (million tons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>39</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Brick (billion pieces)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.5</td>
<td>17.8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Steel (million tons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-3.6</td>
<td>3-3.6</td>
<td>3-3.6</td>
<td></td>
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</tbody>
</table>

Source: http://www.sc.gov.cn

During the housing reconstruction period from August 2008 to April 2009 as we observed, the most needed construction materials in quake-affected areas of Sichuan Province were brick, aggregate, cement with 127%, 125%, and 30% price increase respectively and steel with 30% price drop (See Figure 1-4, source: authors’ own market investigation).

**Figure 1** Brick price trend  
**Figure 2** Aggregate price trend
Much of the supply shortage of these materials came from the large-scale reconstruction demand. In addition, the inadequacy of local production capacity, increased transportation fee, and the scarcity of local raw minerals contributed to the subsequent supply disruption and inflation in disaster-affected areas. Brick supply pressure was also caused by price rising of oil and coal in China. In addition, increasing standards for environmental protection in association with exploitation of natural resources heightened pressure to push up the production cost of brick and aggregate.

The global economic crisis in 2008 had an impact on China’s construction market, with a greatest impact on the steel industry. According to the China Iron and Steel Association (2009), in the second half of 2008, steel producers in China were cutting their production due to the reducing demand for and dropping prices of steel. Nevertheless, existing stocks of steel, made
from raw materials purchased at high price, to some extent exacerbated supplies due to manufacturers’ unwillingness to lower selling prices, which would cause loss of profit. This profit-driven and sort of risk aversion behaviours of Chinese steel makers made the steel supply a problem in the disaster impacted areas.

**Initiatives adopted by policy makers in China**

*Legal framework*

Following the Wenchuan earthquake, The NGC took swift legislative action to establish a multi-governmental management framework for recovery. In conjunction with local municipal and county governments, the NGC, through a variety of programs made ‘sponsoring’ its watchword. In spite of different forms of these initiatives, the key element in common was to stimulate and promote the use of resources both nationwide and locally.

*The Regulations on Post-Wenchuan Earthquake Restoration and Reconstruction* (2008) set guidelines for reconstruction and provided important legal ground for various departments and government agencies to assist with recovery and reconstruction. As a supplementary policy to aid the full implementation of the regulations, *One-on-one Assistance Program for Post-Wenchuan Earthquake Restoration and Reconstruction* (2008) became a key constituent of China’s post-disaster recovery management framework. The earthquake-stricken areas of Sichuan, Gansu and Shaan-xi provinces were divided into 24 districts and twinned with 24 relatively developed localities across China. Sister localities were tasked over the next three years with funding 1% of their annual GDP, provision of human resources and temporary housing units, and in-kind support from planning institutions and other departments in association with disaster reconstruction.
Administrative control versus market-driven resource supply

In response to the inflationary chaos after the earthquake, the NGC, the Provincial Government of Sichuan Province (PGSP), and local authorities took a series of measures including:

- a range of temporary price restrictive interventions;
- directing resource supply to the most severely earthquake-stricken areas; and
- assigning inspectors on the ground to monitor the selling price of suppliers.

In line with the top priority of reconstruction, there was a specific material provision mechanism for reconstruction of rural residences in earthquake-hit areas to meet rural communities’ needs. Temporary price regulations were enforced in forms of fixing the maximum price and profit control against profiteering. For instance, in earthquake-impacted Mianzhu city the maximum selling price of brick was limited to RMB 0.36 per brick, C15 concrete\(^8\) was RMB 315 per cubic metre with the transportation fee included whereas C20 concrete\(^9\) was RMB 345 per cubic metre; the maximum profit of sellers was restricted to 20% for construction glass and 3% for construction steel (Price Bureau of Mianzhu City, 2008). Furthermore, the supplementary ‘price monitoring system’ was set up in a number of material production factories to ensure the effective implementation of temporary price restrictions. These ‘hard intervention’ measures focused on the supply side to directly contain the profiteering behaviour in the construction market. However, the intervention measures also posed a major disincentive to other suppliers to actively get engaged in post-disaster reconstruction resource supply. According to McGee (2008), price controls caused resources to be allocated inefficiently and served to delay disaster relief. The trade-off between levels of directive control and market self-regulation posed a challenge for Chinese policy makers to settle different and conflicting interests of stakeholders without detriment to the disaster-affected region.
Other supportive inputs

During August to December of 2008 as we observed, the PGSP enhanced supportive subsidies for transportation cost and exempted highway tolls for vehicles delivering materials. RMB 0.1 billion (approximate US$14.65 million) of financial aid, was assigned to corporations tasked with specific material production and delivery to designated areas. In addition, the PGSP sanctioned the building of 75 cement production plants, 760 brick factories and 2 large-scale high-performance steel factories to meet the reconstruction demand for the following three years (2009-2011). The PGSP established a transparent supply-demand information platform embracing databases containing demand of construction materials, directories of 95 cement and steel production companies in neighbouring provinces, and detailed daily prices of steel, cement and brick in 51 affected counties (PGSP, 2008). This action however brought about another concern that with supply gradually outpacing demand at the late stages of reconstruction, excess productivity is likely to have a negative effect on the local economy.

The on-going activities of housing reconstruction in China underscore the fact that although governments launched a variety of supporting programs for resource provision to precipitate post-earthquake reconstruction, in reality, the availability, accessibility and affordability of resources still posed a salient obstacle to the housing reconstruction sector after the Wenchuan earthquake, especially in most severely quake-hit counties of Mianzhu, Qingchuan, Beichuan. Resource shortages and cost escalation, along with the constant supply disruption significantly affected the process and performance of housing reconstruction in terms of project time and budget.

This review of resourcing operations for housing reconstruction shows the deficiencies and weaknesses of approaches adopted by Chinese authorities in the aftermath of the Wenchuan
earthquake. The resourcing efforts for post-earthquake reconstruction were mainly driven by governmental agencies and other authorities. The key aspects of a successful resourcing approach including input requirements, market linkage, infrastructure settings and key stakeholders interactions are not yet being addressed.

Nevertheless, the analysis also shows room for improvement in this resourcing practice. Connection of stakeholders involved in resource management in a post-disaster recovery environment is required. The following Section VI aims to empirically identify the responsible stakeholders for resource management in post-disaster reconstruction under the contractor-led resourcing approach.

VI. Stakeholders of post-disaster reconstruction resourcing

Interviewees were asked to indicate the key stakeholders who should take the fundamental responsibility for ensuring resource availability for housing reconstruction following the disaster. The majority of the interviewees confirmed that these key stakeholders were:

• policy makers, notably reconstruction planners and local authorities;
• construction contractors/builders; and
• scientific or research institutions.

Policy makers

The roles of policy makers in the disaster-stricken areas were highlighted by all of the interviewees and some of them (C4, C5-6, C12, R3-4 and G1-G5) compared the function of those key figures to an ‘incubator’ which could nurture the post-disaster resourcing environment
if working towards the facilitation of a successful disaster recovery. Both interviews and literature, such as Olshansky et al. (2006), show that external funding and resources are important prerequisites for successful housing reconstruction and national governments need mechanisms to be able to deliver these, allowing local flexibility in implementation.

According to the interviewees (C2-5, C8, C10-11, C15, R4, and G2-4), reconstruction planners are central to designing the method, the process and priorities of restoration and reconstruction work. In addition, some interviewees (C1, C6-7, R4-5, and G3) suggested that the predominant role of local authorities in disaster-impacted areas should be capitalized on for local resource utilization and exploitation, as they are familiar with the local context. This critical role of local governments is also manifested in the State Overall Planning for Post-Wenchuan Earthquake Restoration and Reconstruction (2008):

‘The people’s governments at various levels in disaster areas shall actively manage the production, allocation and transportation of the restoration and reconstruction materials, ensuring supply and stabilizing price. The states shall support and coordinate the organization of goods supply and transportation guarantee.’ (Chapter XV 4.1)

**Construction contractors/builders**

The construction industry is not only a critical component of the nation’s economy, but also a fundamental contributor in disaster management and mitigation (Spence and Kelman, 2004; Pheng et al., 2006; Zuo et al., 2006). Some interviewees C2-C6, C8 and C12 highlighted the main pronounced difference of project management in post-disaster rebuilding, as C2 stated:
In comparison with pre-event construction, project managers working on post-disaster projects need to abide by local reality of limited resources and constraints, of lack of access to resources, and of the chaos originated by the disastrous event. (C2)

In regard to post-disaster reconstruction, most interviewees (C1-C8 except C4, C9-C14, R4 and G1) regarded construction contractors/builders as being pivotal to realize the ‘build back better’ ethos. These interviewees along with G3 and G4 felt that builders/contractors could be more proactive, with their expertise and skills, to get engaged in resourcing and ensure resource availability for their projects. This perspective concurs with the findings of the Max Lock Centre (2006) (on behalf of the Tsunami Recovery Network), that property and construction skills can add value to disaster management and recovery in areas of sourcing construction materials and equipment, procurement and project management, and aiding logistical planning. This also accords with the study of Zuo et al. (2006) who claimed that construction contractors serve as a pivotal bolster for resource availability in post-disaster reconstruction.

The interviewees C1-C4 and C9 stated that due to the intricate nature of the post-disaster environment, inherent resourcing problems hidden in previous mechanisms would emerge during the reconstruction process. For example, during the Wenchuan earthquake housing rebuilding, when facing resourcing difficulties, some construction firms used the opportunity to review their procurement operations, pinpoint the root causes of these problems and formulate possible ways to address the issues. As construction coordinator C2 claimed:

‘Post-disaster reconstruction could enable the construction industry to become more resilient and capable and consolidate the relationships among project stakeholders, thus ensuring
collaborative resourcing practices when facing resource unavailability and improving quality of the rebuilding projects.’ (C2)

In this regard, post-disaster reconstruction serves as a ‘window of opportunity’ for the construction industry in the disaster stricken region to thrive under a challenging circumstance.

**Scientific or research institutions**

The interviewees C5, C16, R2-3, R5 and G2 raised the important role for scientific or research institutions in material-related research and application. They advocated that more research on the alternatives to building materials should be encouraged and invested by government to identify environment-friendly, energy saving and disaster resistant materials. However, they also stressed their concern over the local acceptance of new types of construction materials. Interviewees suggested that governments should take initiatives to promote the widespread application of new developed materials and improved construction methods in the rebuilding areas; and research institutions need to base themselves on the ground to solicit ‘grassroots’ opinions’ to address these concerns.

During the interviews, a multi-stakeholder cooperative approach was suggested for a successful resourcing process in post-disaster reconstruction situations. Involvement of local government and representatives of the construction industry is critical for linking the learning process to the overall resourcing capability. Additionally, involvement of national government and related research institutions is vital for linking the resourcing issues to the legislative and policy system.

**VII. Constraints in post-disaster resourcing environment**
Interviewees were asked to indicate the impediments to resource availability during post-Wenchuan earthquake housing reconstruction period\(^{10}\). Such a discussion would show the causes of resourcing problems existing in the post-disaster context and other deficiencies in current reconstruction practice in China. The most significant constraints identified are discussed below.

**Insufficient legislative regime**

Legislation and policy packages have been regarded by a number of researchers as an overarching imperative to allow effective coordination and delivery of reconstruction work (Godschalk, 1999; McEntire et al. 2002; Birkland, 2006; Masurier et al., 2008). For example, the contrast in housing reconstruction process and outcome after the earthquakes in Mexico city, Mexico 1985 and in Kobe, Japan 1995 demonstrated the significance of policies on a desirable recovery (Comerio, 1997). Complex post-disaster conditions dictate legislative and regulatory environments which are more compatible with reconstruction operations (Imrie and Thomas, 1997).

Most interviewees (C2-C11 except C8, C13-C16, R2, R4-5 and G2-4) stressed that the inception of ‘the Regulations’ and the ‘One-on-one program’ aided the deployment and mobilization of resources for Wenchuan earthquake recovery and reconstruction considerably. However, these regulations and the program were likely to be insufficient due to the initial lack of legal considerations in China for long-term post-disaster reconstruction (Ying, 2009). This is in accordance with the reconstruction fact of Indonesia and Sri Lanka after the Indian Ocean tsunami (2004), and in New Orleans after Hurricane Katrina (2005), that pre-existing legislation and policy seemed to be unable to cope with post-disaster situations (Zuo et al., 2008), especially after a large-scale disaster (Masurier et al. 2006); inappropriate legislative and governmental system could substantially limit the recovery progress (Burby, 2006; Nazara and Resosudarmo,
and hinder reconstruction resource procurement and utilization (Hanaoka and Qadir, 2005).

The interviewees C2, C7, R4 and G2-G3 mentioned a couple of examples where the existing legislative clauses can only apply to the emergency response as opposed to the longer term reconstruction and recovery. For instance, in the Emergency Response Law of the People’s Republic of China (2007), it is stipulated as:

‘The state shall establish and enhance an emergency response material reserve security system to improve the supervision, production, reserve, allocation and urgent distribution systems of the major emergency response materials.’ (Chapter II, Article 32)

And similarly, the State Overall Planning for Post-Wenchuan Earthquake Restoration and Reconstruction (2008) stated:

‘Ameliorate the reserve system of disaster relief materials so as to improve the reserve capacity.’ (Chapter X, 2.3)

Those two guidelines merely show the imperative for establishment of resource reserve systems in response to emergency, without considerations given to longer term reconstruction requirements. The resourcing difficulties which emerged after the Wenchuan earthquake, however, gained particular attention from decision makers and practitioners with regard to ensuring that suitable and adequate resources are effectively managed in the disaster recovery process.

Interviewees C2-C5 and R3 indicated that resources needed for the reconstruction phase differ from that of the response stage; the former refers to resources for construction projects whereas the latter largely concerns itself with basic relief materials and equipment such as medicines and
necessities for daily life. Another example raised by the interviewees C2, C9-10, R4 and G3 is that resource supporting programs mandated in the pre-existing laws are also mainly targeted at emergency response rather than post-event recovery and reconstruction. For instance, in the Emergency Response Law of the People’s Republic of China (2007), it is stated that:

‘The state shall ..., encourage and support the teaching and scientific research institutions and relevant enterprises to conduct research and development of new technologies, new equipment and new instruments for the emergency incident prevention, surveillance and warning and the emergency response operations and rescue.’ (Chapter II, Article 36)

In addition, during the interviews, academics R1 and R3-5 posed environmental concerns which present as potential threats to the natural environment and ecology when utilizing resources locally. Nevertheless, according to them, there is no existing environmentally-specific mandate in China to address these worries. The lack of enforceability of environmental regulations enacted at the local level is also a major drawback in earthquake-impacted areas, which would create potential vulnerabilities to future disasters.

Some interviewees C1, C10-12, G1 and G3 stated that a satisfactory level of resource availability for housing reconstruction requires sensible prioritization and phasing of the overall reconstruction process. Belassi and Tukel (1996) proved that the urgency of a project plays an important role in post-disaster reconstruction. Much of such urgency comes from livelihood recovery, notably residential reconstruction, which is often the top priority for disaster-affected communities. After the Wenchuan earthquake, as some interviewees mentioned, with the winter drawing near, reconstruction works were accelerated in some quake-hit areas where local officials had promised that no-one in the quake-hit area would live in the makeshift tents during
the wintertime. This political imperative to speed up human settlement reconstruction, to some extent, intensified the supply strain of the major building materials in these reconstruction areas.

**Inadequate construction industry resourcing capability**

The nature of resourcing in post-disaster reconstruction makes it far from the traditional procurement strategy (Zuo et al., 2006). However, according to the contractors interviewed (C3, C7, C10, C14, C12 and C15), the construction industry in China has not been sufficiently prepared for and involved in the changing built environment after a disaster; and the awareness to engage in disaster prevention and management is poor. During the Wenchuan earthquake reconstruction, they undertook building work just as routinely as in normal times. As they stated:

‘We just do what we normally need to do in the construction process according to the requirements of regulatory agencies and house owners’ (C3); ‘We really didn’t realise we are contributing to reduce vulnerability of potential disaster risks’ (C7, C10, and C14); and ‘Even we knew our significant role in future disaster prevention, disaster management and construction still appear to be separate subjects’ (C12 and C15).

This situation bears resemblance to that of other countries such as Indonesia (Pribadi et al., 2003), Iran (Gharaati, 2006), Sri Lanka (Pheng et al., 2006) and UK (Bosher et al., 2007). The segmentation between disaster management and construction sectors is manifested in many aspects in these countries, such as in education, planning, operations and daily activities. This to a great extent hinders the inclusion of professions from the built environment into hazard mitigation on a sustainable agenda.

Some contractor interviewees C1-C4, C7 indicated that resourcing difficulties and challenges they encountered during post-earthquake reconstruction highlighted superior resourcing
performance of large-scale contractors when considered alongside small and medium size practitioners. This is consistent with the research findings of Athukorala and Resosudarmo (2005), and Lyons (2009), that large and well-established businesses are more likely to recover faster and be able to engage in reconstruction. Zuo et al. (2006) also pointed out that large scale contractors are capable of procuring resources needed in a disaster due to their long-term relationships with subcontractors and suppliers, and these linkages determine their successful acquisition of resources in the hierarchy of post-disaster reconstruction (Masurier et al., 2006).

In addition, according to the interviewees C2-C4, C7-C10, and C15-16, except for a few large-scale construction companies which had resourcing contingency plans integrated into their whole project plans, there were no set schemes and strategies regarding post-disaster reconstruction. And there were few training systems existing in the market specifically for enhancing the resourcing capability of players in the construction industry. As the interviewee C15 commented that:

‘Resourcing issue was always decided after the disaster which prevents the construction sector from being ready against the disasters, and potential resources being used efficiently’.

(C15)

The statement shows that construction professionals have not yet found appropriate participatory way to disaster reconstruction and also underlines the importance of planned pre-event solutions for the post-disaster reconstruction process, involving enhanced participatory planning approaches in construction organizations.

**Fragile local production system**
Some interviewees (C9-C11, C14, R5 and G2) and researchers such as Athukorala and Resosudarmo (2005), and Jayasuriya and McCawley (2008) indicated that resource availability during post-disaster reconstruction to some degree relies on the local pre-event economic conditions. For instance, the quake-impacted Mianzhu city, as an industrial base in Sichuan Province before the earthquake, was more likely to furnish resources required for its reconstruction needs. In contrast, the housing reconstruction in Beichuan, an agriculture-based town, without an adequate material production capacity, had been suffering from longer-term resource shortage and unavailability.

‘This devastated township had to import main building materials from other parts of China during reconstruction due to its original low productivity, as a result, some of rebuilding projects were delayed and over-budgeted’. (G4)

When asked how to increase the variety of building structures and materials, the interviewees (C5, R2 and G4) and literature such as Schilderman (2004) and Boen and Jigyasu (2005) mentioned a common problem, as alluded to earlier in this paper, that the lack of understanding of new types of construction materials prevents their wide use and application in earthquake affected areas. In fact, according to the interviewee G2, the essential function of the construction market in post-disaster reconstruction has been largely neglected; new types of construction structures and materials should be channelled through the local market on a basis of more community consultation and needs assessment.

**Vulnerable transportation system**

The transportation systems such as roads, airports, railways provide essential access to available resources needed for a country’s rapid and successful recovery. Some studies looking into post-
disaster logistics have shown that the high cost of resource transportation (Limoncu and Celebioglu, 2006) and lack of delivery alternatives (Singh, 2007) were major barriers to post-disaster reconstruction. According to Asian Development Bank (2007), after the Indian Ocean tsunami, Aceh experienced a shortage of cement, which, coupled with price speculation, drove up cement prices in Aceh by 63%. A significant portion of this price gap is attributed to high transportation costs as a result of the limited port and shipping capacity along with lengthy transportation times.

Likewise, the devastating Wenchuan earthquake and aftershocks have highlighted the vulnerability of transportation systems in disaster-affected areas. The interviewees R4, G3 and G5 stressed that the road and railway system in the earthquake affected areas was mainly damaged and disrupted by a large number of secondary hazards, such as landslides, landslips, mud-rock flow and ‘quake lakes’. Reopening access was a slow process due to the particular mountainous topography and lack of access greatly inhibited the recovery process. During the authors’ observation in Mianzhu in December 2008, all modes of transport for delivering building materials to construction sites were applied, including human and pack-animal carrying methods.

The Transport Ministry of China approved four river-land joint routes for large cargo delivery by fully capitalizing on a comprehensive national transport system. For example, one of the four lines was from Shanghai via Chongqing to Chengdu. The recovery and reconstruction resources were shipped from Shanghai to Chongqing through Yangze River and then transferred to the earthquake affected areas through Chongqing-Suining highway (295 kilometres), Chengdu-Chongqing highway (339 kilometres) and Yuling highway (413 kilometres). However, as interviewee G5 mentioned, these post-event ad hoc strategies for extending transport capacity
would lead to a potential of transportation conflicts between existing delivery activities and reconstruction needs and to some extent add difficulty in overall coordination and deployment of resources nationwide.

**Environmental concerns**

Having resources quickly available is of primary importance after a disaster but the successful exploitation and utilization of resources must also correspond to environmental objectives and economic and social sustainability in disaster-stricken areas (Shaw, 2006). Some scholars have expressed resourcing-related environmental concerns and suggested a number of methods to incorporate these environmental issues into recovery, such as introducing a ‘green space’ as a priority in reconstruction planning (Greene, 2008), bringing appropriate waste and debris management policies into recovery plans (Shaw, 2006), combining sustained self-employment strategies with environmental protection (Winchester, 2000) and encouraging sustainability through legislation (Budidarsono et al., 2007).

With regard to China’s Wenchuan earthquake reconstruction context, the interviewees C1, C10, R1, G1 and G3 came up with two prominent environmental problems:

- Raw material exploitation for making building components and products posed a threat to the natural environment; and
- Inappropriate sourcing approaches are likely to induce secondary hazards.

According to the interviewees C1, C9, C15 and R1-3, shale-made brick, as a conventional masonry material, was the most needed building material in mountainous affected areas. However, the excessive shale mineral exploitation was likely to degrade the river banks, damaging the eco-system and livelihood nearby. The interviewee R1 suggested that deforestation
for satisfying massive reconstruction logging needs also exacerbated the negative earthquake impacts.

‘The most deadly disaster in China’s history triggered unprecedented large-scale reconstruction and recovery, which would inevitably induce massive resource exploitation, especially the non-renewable resources like wood. The excessive logging, if neglect the capacity of local natural environmental, leads to forest reduction and environmental degradation’ (R1)

The interviewee R2 and literature, such as Shaw (2006), confirmed that logging, both legal and illegal, contributed to the incidence of flooding and landslides. In addition, the interviewees R1 and R3 mentioned that the high volume of waste and debris from earthquake destroyed buildings and from secondary hazards like rock-mud flow, also contributed a major concern for proper disposal. Albeit,

‘Local government is formulating policies to assist with recycling construction wastes in a commercial manner. By combining land provision by the local government, enterprise investment and market-oriented operation to realize the reuse of 0.5 billion tons of construction wastes produced by the earthquake destruction’. (R1)

In this sense, protecting the natural environment and ecosystem from the threat of the massive demand of reconstruction and the subsequent resourcing activities should be regarded as a task of building sustainability for both decision makers and reconstruction practitioners.

Based on the identified resourcing constraints in Wenchuan earthquake reconstruction context, the remainder of this paper tackles the second research question: ‘What needs to be addressed to enhance resourcing availability for rebuilding projects after a disaster?’
VIII. Planning framework for post-disaster reconstruction resource availability

The extensive analysis of interviews provides a multi-perspective view of the resourcing issue in a post-disaster situation. The findings of this study identified key stakeholders and constraints in post-disaster resourcing process and showed that the prevailing structural and social conditions could have a major influence on the success of resource management after a disaster. A possible solution to address such pre-event deficits is to introduce measures that can minimize them into the general development planning (Wamsler, 2006). A holistic planning framework (Figure 5) is thus proposed which incorporates all problems identified and elements discussed in the previous sections.

**Figure 5** Integrated planning framework for post-disaster reconstruction resourcing
The ideas demonstrated in the proposed framework have been discussed with some of the interviewees, and would be further examined in other two parallel studies being conducted in Banda Aceh, Indonesia and Marysville, State of Victoria, Australia, in order to supplement the research findings at an international level. The framework is hoped to have a potential to guide practitioners to understand, visualize, coordinate and manage various post-disaster resourcing issues effectively.

**Legislation and policy revamping**

The Wenchuan earthquake is an illustration of legislation and policy being introduced post-disaster. The adequacy of existing legislation and policy needs to be reviewed prior to future disasters and revised and developed further in order to facilitate effective resource acquisition and utilization for long-term recovery and reconstruction in China. To ensure post-disaster reconstruction resource availability, there is a need for a major reorientation of resource acquisition planning from reallocation tactics to developing alternatives. There is also a need for decision makers at higher levels involved to give due consideration to real rebuilding needs and local capacity of material production in earthquake-hit areas to align resources more closely to markets and requirements of the people affected.

To avoid legal limitations for post-disaster reconstruction, efforts should be made to revise the existing legislation and to develop a specific legislative portfolio compatible with resourcing needs in the disaster context. Local government may have to make legal strategic plans for housing rebuilding part of a sustainable recovery. The NGC should then take steps to reinforce local governments’ commitment to planning and implementation. For instance, promoting specific provisions for housing insurance is the preliminary step towards an environment that
encourages a culture of insurance in China. Furthermore, there is a need to develop the law for logging and reforestation to make local wood resources accessible for people affected without detriment to the natural environment; and by changing buildings codes to promote upgraded materials for post-disaster reconstruction projects.

It is also clear that an effective enforceable mechanism of legislation and policy pertaining to post-disaster recovery and reconstruction is needed for the formulation of an overall resourcing system and critical to its outcomes after a disaster. This could possibly be achieved through an establishment of a special institution/agency fully empowered by the NGC.

**Construction industry capability enhancement**

When planning for post-disaster recovery, the construction industry can play its part in enhancing capability for physical reconstruction, especially in skill and technique upgrading, and incorporating risk reduction and disaster prevention elements into construction work. To enhance this ability, practitioners need to adapt to the post-disaster changing environment by utilizing knowledge and skills acquired through experience training provided by the industry. Such training should address information collecting, communication, purchasing strategy, negotiation skills, etc. and has considerable relevance not only for fostering future practising managers, but more importantly, the kind of management and procurement that construction organizations can adopt. There is also a need within the construction industry to design innovative programs to heighten the awareness of these industry players to proactively get engaged in disaster management and prevention.
A well-conceived resourcing plan for a possible rebuilding project in a disaster scenario conveys that the contractor organization is aware and prepared for the resourcing issues in the recovery process. Furthermore, by involving and consulting with suppliers and sub-contractors in all phases of resource planning, construction contractors can develop a resource database system, the core of a pre-disaster resource plan, which helps create a systematic procurement strategy by continuously inputting timely and accurate information. An inventory of procurement methods and partnerships is also crucial for providing a basis for designing appropriate resourcing strategies based on variations in organizational capacities and experience with planning. Furthermore, the adoption of a multi-project inventory strategy might be a likely option for coping with resource shortages in post-disaster reconstruction situations in terms of saving transaction cost, lead time and other onerous procedures with regard to resource procurement.

**Market re-measurement and re-structuring**

Effective post-disaster reconstruction relies on efficient market planning. In most cases of post-disaster reconstruction, resources were supplemented by creating a large number of new production facilities or by reallocating resources from existing uses to reconstruction projects. However, partnerships between businesses and local authorities may offer a significant opportunity for concerted market and economic planning and improving the market function and mechanisms, thus the alternatives to the above could be:

- strengthening the market flexibility by exploring resourcing channels nationwide;
- adoption of cost-effective technology in the development and production of construction products and materials; and
- assessment of the local productivity and construction industry capability.
There is a need for construction authorities in conjunction with related sectors to design a variety of education, training and assistance programs in the market to equip the relevant actors for coping with potential future disasters. This could be addressed by:

- large-scale construction companies providing procurement expertise to assist small and medium-size corporations with resourcing procedures, assessing quantities of resources required and strategic procurements skills to reduce lead time and cost;
- local governmental construction departments playing an important role in facilitating technical assistance by providing financial or in-kind support to launch a series of training initiatives; and
- local authorities in charge of the construction market launching regular training and recruitment activities in pre-event situations for local communities to attract and absorb more human resources, to get local communities prepared and equipped for a future disaster and reconstruction, and to allow a ‘personnel reserve buffer’.

**Transportation planning for capacity development**

Given the importance of transportation in the post-disaster resourcing process, the strategies for transport capacity development should:

- be integrated into the pre-disaster mitigation programs and local redevelopment planning;
- be targeted at transport alternatives to enhance the resistance and resilience of the transportation system in disaster-prone areas; and
- be in line with industrialization and urbanization in disaster-impacted areas taking account of natural environmental conditions and capacity.
In accordance with specific characteristics of topography and seismicity in disaster prone areas, more risk and disaster withstanding approaches should be integrated into post-disaster lifelines reconstruction to reduce the vulnerability to potential hazards. A robust transportation network, if developed along with communication facilities, will make the management and coordination of relief and reconstruction resources feasible and will allow for further improvement of post-disaster reconstruction performance.

**Environmental considerations into overall planning**

A proper understanding of linkages between disasters and the natural environment as well as an environmental-friendly resourcing approach should be promoted and integrated into the overall planning system to avoid, minimize, and resolve potential environmental issues.

Reconstruction processes should be considered as a re-development opportunity with environment protection as a priority in the sustainability agenda. The emphasis of the governments, however, should be more on environmental management of the reconstruction process. This entails environmental considerations be linked to legislation. Environment protection, as a ‘conduct code’, should be incorporated into the daily resource utilization, production and waste disposal activities of players in the construction industry and market.

**IX. Conclusion**

To attain a resilient and sustainable post-disaster built environment, the first priority must concern the implications of resource availability on reconstruction effects and potential bottlenecks in the resourcing process. As many recovery problems faced in disaster-impacted
areas related to housing, resource availability intrinsically links with the specific post-disaster context as well as the chronic conditions of vulnerability in existence long before the disaster.

This paper reveals five primary barriers to resource availability confronting post-Wenchuan earthquake housing practitioners. The insufficient legislative regime for long-term post-disaster reconstruction, along with the lack of resourcing capability in the construction industry is a long-standing, inherent and considerable disadvantage. The fragile infrastructure and vulnerable material production and supply systems in the affected areas also caused resourcing frustrations during reconstruction. By linking resourcing with broader plans for sustainable and equitable post-disaster reconstruction, more fundamental action both before and after the disaster can be taken to reduce socially and physically produced resource shortage.

A conceptual planning framework was presented to provide a vision which synthesizes areas where stakeholders should concentrate effort to ensure resource availability for housing rebuilding projects. Pre-event planning for resource availability in a disaster situation does not mean simply finding more resources for housing reconstruction, it involves finding strategies to limit the cost of resource provision and increase accessibility to available resources to meet a variety of local conditions. The planning model presented offers a view for reconstruction decision makers for better legal and institutional considerations to facilitate reconstruction work and reinforce policy execution capability.

The research in this paper supports the common findings from previous studies — highlighting the importance of legal framework, engagement of the construction practitioner, market linkage, transportation robustness as well as environmental considerations. However, through a thorough case study, this paper extends many of these findings in a way relevant to the perspective of
planners and project managers operating in the built environment. The case study focused on the contractor/builder-led resourcing mode in housing reconstruction, as opposed to owner-led resourcing practice. Hence, future research regarding differences of using these two models is likely. The proposed conceptual planning framework directs attention to improving resourcing performance of involved stakeholders. It is primarily concerned with two related issues: coordination of organizations charged with response and recovery, and ensuring that proper resources are available when needed in the aftermath of a disaster. The related operative measures and coordination initiatives to achieve this framework are critical issues for future research.

It is clear that encouraging dialogue with a wide variety of stakeholders at different levels, establishing mutual assistance mechanisms and focusing on the community’s needs have escalated to the top of reconstruction strategy agendas in China. The Wenchuan earthquake — reflected in this paper, created political and social openings in which longer-term housing development issues could be addressed by integration of various well prepared and equipped stakeholders.

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**Endnote**

1 M 8.0 represents surface wave magnitude (Ms), the national standard used by the Chinese government for earthquake magnitude. M7.9 for the Wenchuan Earthquake from The United States Geological Survey (USGS) reports represents moment magnitude (Mw).

2 As of September 11, 2008 noon

3 A selection of the survey publications on the Wenchuan Earthquake is available from the website of the organizations: Earthquake Engineering Field Investigation Team, Earthquake Engineering Research Institute, Multidisciplinary Center for Earthquake Engineering Research (MCEER), United States Geological Survey (USGS), and National Center for Research on Earthquake Engineering.
R1 is Associate Professor from the School of Environmental and Civil Engineering at Chengdu University of Technology. R2 is Associate Professor from the Department of Construction Materials and Technology at Sichuan University, China. R3 is Professor from the Department of Construction Materials and Technology at Sichuan University. R4 is Professor from the Department of Construction Management at Sichuan University. R5 is Associate Professor from the Department of Construction Management at Sichuan University.

G1 is from the Construction Bureau of Mianzhu People’s Government, G2 is from Provincial Government of Sichuan Province (PGSP), G3 and G4 are from Headquarters of Wenchuan Earthquake Reconstruction and Rehabilitation in Sichuan Province, G5 is from Transportation Planning Bureau of Sichuan Provincial Communications Department.

Price contrast is between in pre-earthquake April 2008 and in post-earthquake February 2009. Data was obtained through the authors’ personal communication with officers in Price Bureau of People’s Government of Mianzhu City, Sichuan Province and field-based market investigation.

In Figure 1-4, in order to present a better effect of the chart, the price was measured in Chinese currency unit RMB, not converted into USD currency unit.

C15 concrete is a type of mixing concrete with a compressive strength of 15 N/mm². C is the compressive strength grade.

C20 concrete is a type of mixing concrete with a compressive strength of 20 N/mm². C is the compressive strength grade.

The reconstruction time for housing sector was two years according to The State Overall Planning for Post-Wenchuan Earthquake Restoration and Reconstruction (2008). The overall post-disaster housing reconstruction and rehabilitation started in August 2008.