Impacts of Stressors and Stress on the Injury Incidents of Construction Workers in Hong Kong

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Abstract: Construction workers (CWs) are the key and indispensable contributors to every construction project. Their psychological feelings greatly influence their behaviors and safety performance. To improve CWs' safety performance in dangerous working environment, the current research aims to identify the various stressors affecting two types of stress of CWs (i.e., job stress and emotional stress) and to explore the impacts of the two types of stress on CW injury incidents in Hong Kong. Eleven stressors were identified through *factor analysis*: work overload, role ambiguity, lack of autonomy, unfair reward and treatment, appropriate safety equipment, optimism, interrole conflict, poor workgroup relationship, lack of feedback, poor physical environment, and unsafe environment. The results of *correlation* and *regression analyses* reveal that (1) among the two types of stress identified, *injury incident* of CWs was found to be affected by emotional stress only, (2) *emotional stress* is predicted by work overload, interrole conflict, poor physical environment, unfair reward and treatment, and appropriate safety equipments, and (3) poor workgroup relationship, work overload, and interrole conflict predict job stress of CWs. Based on the result, various recommendations are suggested to employers on how to minimize CW injury incidents.

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Introduction

As staff in various work trades of construction projects (such as concrete work, machine and crane operation, plumbing and piping, painting, electrical work, carpentry, and so on), construction workers (CWs) are the front-line force of every construction project (Fung et al. 2005). The performance of CWs has direct and significant impacts on the success of construction projects and on the profitability of construction companies (Applebaum 1999). In Hong Kong, an average of 257 injury incidents occurs every month among the 267,800 laborers in the construction industry (HK Census and Statistics Department 2008). Statistics also show that the construction industry's injury incident in Hong Kong is the highest among all industries in the territory; indeed, CWs were the victim in 75% of all annual occupational fatalities in Hong Kong in 2008 (HK Census and Statistics Department 2008). The often tight project budgets and schedules in Hong Kong, even tighter nowadays due to the adverse economic and industrial environment, have driven construction personnel to be predominately production-oriented at the expense of the health and safety needs of CWs (Mitropoulos et al. 2005). Facing repetitive but physically demanding tasks within crisis-ridden environments, having little power, and lack of support and concern from their organizations and the public, CWs are 1.7 times more likely than workers in other industries to have psychological health problem, including emotional and stress-related problems (Petersen and Zwerling 1998). Stress affects CWs' awareness of and compliance with safety measures (Choudhry and Fang 2008), which are the major causes of occupational injury incidents (Mearns et al. 2001). The current study, therefore, aims to investigate the impacts of stress on CW injury incidents and to explore the various stressors affecting CW stress levels.

Stressors of CWs

Arising from monotonous but demanding task conditions, inadequate interpersonal support, deficient organizational safety climates, poor physical environments, and unbalanced effort-reward systems, *stress* can often easily manifest itself as tension or dissatisfaction and can influence the psychological health and performance (i.e., ineffectiveness, injuries, and low productivity) of individuals (Cooper and Sutherland 1987; Djebarni 1996; Mearns et al. 2001; Siu et al. 2004). Based on the previous stress management research in the construction industry (Leung et al. 2007, 2008a, 2009), stressors faced by CWs can be categorized into five groups: *task-related, organizational, personal*, *interpersonal*, and *physical*.

Task Stressors

Though the work of CWs is often repetitive (e.g., painting and excavating on ground), it is generally demanding in nature, both

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cognitively and physically. *Work overload*, which means that the job demands are too great for one individual (Margolis et al. 1974), not only affects individuals' stress levels but is also associated with occupational injury incidents (Frone 1998; Elfering et al. 2006). On the other hand, as CWs' education levels are generally low, unclear communication with foremen and colleagues can occur and may easily lead to vague understandings of work responsibilities and objectives. Hence, *role ambiguity*, which is defined as a lack of clarity about the expectations of the work role and about the scope and responsibilities of the job (Beehr 1995; Leung et al. 2009; Rizzo et al. 1970), can easily occur. In addition, many construction projects in Hong Kong are subcontracted, a phenomenon that carries multiple layers of authority and an organizational hierarchy in which CWs are normally positioned at the lowest level. Owing to their limited understanding of projects, CWs have limited control and thus a *lack of autonomy* in their work. Lack of autonomy, which is defined as "the degree to which the job provides substantial freedom, independence, and discretion in scheduling the work and in determining the procedures to be used in carrying it out" (Hackman and Oldham 1975; p. 162), was found to predict stress level of individuals (Beehr 1995; Kalleberg et al. 2009).

Organizational Stressors

Rewards and treatment of CWs are often overlooked due to their low position in organizations or even unreasonably diminished due to projects' tight budgets. Insufficient and *unfair rewards and treatment* increase people's vulnerability to stress (Maslanka 1996; Niedhammer et al. 2006). On the other hand, though ensuring safe working environments is the responsibility of organizations, employers may still fail to provide appropriate and regularly maintained safety equipment to CWs on site (Hinze 1988; Zou et al. 2007). Going without *appropriate safety equipment* certainly induces psychological stress in CWs, who work in crisis-ridden environments every day.

Personal Stressors

Type A behavior is a behavior pattern characterized to be aggressive, competitive, hasty, time impatient, insecure about status, hostile, self-critical, and incapable of relaxing. Individuals with type A behavior are more vulnerable to stress (Friedman and Roseman 1974; Evans 1990; Leung et al. 2008a). In contrast, individuals with high levels of *optimism* maintain a positive view of personal situations and believe that people and events are inherently good. Hence, optimistic individuals are reported to suffer less stress, depression, and burnout (Scheier and Carver 1992; Hayes and Weathington 2007).

Interpersonal Stressors

Role conflict occurs when the different roles with which a person identifies conflict with one another, affecting the performance of these roles. Stress may result if one of these roles is overloaded (Barnett and Marshall 1993; Leung et al. 2009). On the other hand, construction projects can be multiprocessing, as workers of different trades (e.g., formwork, reinforcement, concreting) may work on a site at the same time. Communication and interaction between supervisors, colleagues, and different parties are necessary for CWs. A *poor relationship within workgroups* leads to stress and poor performance (Lundberg 2006), while good communication between workers and foremen enhances safety (Hinze 1981; Reese and Eidson 2006). However, due to their low position in the industry, CWs often receive *inadequate feedback* or attention from their supervisors and from management personnel. This lack of adequate feedback induces stress on CWs (Leung et al. 2007).

Physical Stressors

CWs work on construction sites wherein they must endure *poor physical environments* with conditions such as extreme temperatures, poor air quality, and excessive noise. Prolonged periods of working in adverse physical environments not only induce stress in individuals (Vischer 2007) but also affect their safety and their ability to perform tasks (Driskell and Salas 1991; Goldenhar et al. 2003). On the other hand, poor housekeeping (e.g., the improper placement of equipment and insufficient indicators and lighting) can also cause hazards to CWs on construction sites. These *unsafe working environments* may then induce stress in individual CWs and lead to higher on-site injury incidents.

Stresses and CW Injury Incidents

When discussing "stress" in the construction industry, people have in the past generally been referring to the forces or pressures exerted on or borne by particular parts of a building structure. In today's society, however, people have started to become aware of "human stress," especially the stress experienced by construction industry personnel (CIOB 2006; Janssen et al. 2001; Leung et al. 2009). Nevertheless, the definition of "stress" still varies from researcher to researcher. In order to be comprehensive, the current study investigates two different types of stress among CWs: *job stress* and *emotional stress*.

Job stress is induced when there are discrepancies between an individual's expected ability to deal effectively with the given tasks and his or her actual ability to do so (Gmelch 1982; Leung et al. 2008b; Monat and Lazarus 1991). It refers to the evaluation of a threat or source of stress arising from cognitive factors, such as the number of construction work tasks handled by CWs, the level of difficulty of their tasks, the degree of skills required (e.g., new techniques for innovative construction methods), and the number of people that they have to work with (e.g., colleagues, supervisors, foremen, and CWs in other work trades). When the outside expectations exerted on individuals exceed those individuals' abilities, overstimulation can occur. In such situations, CWs may tend to put more effort into their work tasks and be less alert to safety. Subsequently, injury incidents can occur on-site (Goldenhar et al. 2003; Rundmo 1995).

Emotional stress occurs when, due to prolonged exposure to stressful conditions, individuals are emotionally drained, chronically fatigued, and lose the ability to devote themselves to their job duties (Goliszek 1992). Emotional stress can further lead to feelings of frustration and exhaustion (Cordes and Dougherty 1993). Individuals suffering from emotional stress may then ignore safety requirements, resulting in an increased risk of injury incidents (Alexander and Klein 2001; Elfering et al. 2006; Frone 1998; McMurray 1968). In fact, emotional exhaustion is one of the three widely adopted burnout symptoms defined by Maslach et al. (1996). Emotionally exhausted individuals may further experience depersonalization and reduced personal accomplishment (i.e., the other two burnout symptoms). However, as the current study contains variables which are similar to the later two symptoms, such as workgroup relationship and job stress, to prevent

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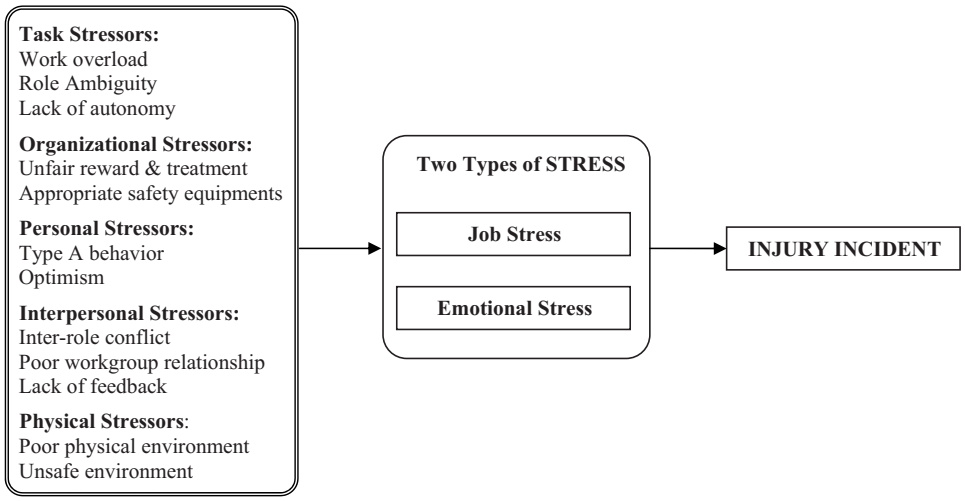

Fig. 1. Conceptual model of stressors-stress-injury incident for CWs

including variables conveying essentially similar information in the study, only the concept of emotional exhaustion is included in the study.

Although the negative linear relationship between stress and performance is widely recognized, stress is not necessarily harmful (Abramis 1994; Ivancevich et al. 2005; Jamal 1984; Robbins 2005; Selye 1974). Excessive stress has negative impacts on individual performance, but insufficient stress can also have negative effects on performance (Gmelch and Chan 1994; Leung et al. 2005). If outside expectations (in terms of work tasks and emotion triggers) are not sufficiently high, individuals can suffer from understimulation (Gmelch 1982). This has been especially true during the recent recession period in the construction industry, when CWs have not had enough work. In such situations of understimulation, individuals' job satisfaction, motivation, and, more important, concentration decrease (Varhol 2000). Risk of injury incidents would increase if individuals' concentration and attention at work decrease (Murray et al. 1997). Hence, both too much and too little stress can lead to high CW injury incidents. The current study predicts that the relationship between stress and CW injury incident are both linear and curvilinear (i.e., inverted U-shape) and only moderate stress levels lead to minimal injury incidents in certain situations.

Conceptual Model

In sum, it was hypothesized that the various task stressors, organizational stressors, personal stressors, interpersonal stressors, and physical stressors induce job stress and emotional stress in CWs, which further predict their injury incident. In fact, CWs inevitably face uncontrollable stressors while working in the dynamic and fast-paced construction industry. The injury incident of CWs is therefore always high in comparison to that of laborers of various other industries. The conceptual model of the various stressors, types of stress, and injury incidents of CWs is illustrated in Fig. 1.

Research Methodology and Result

Sample

To investigate the impacts of various stressors on the stress levels of CWs and the effects of stress on CW injury incidents, a questionnaire was designed and disseminated to CWs in Hong Kong during the period of October 2008 to January 2009 via fax, e-mail, and in person. In order to control the quality of the data collection and maximize the sample size, purposive sampling, in which subjects are selected because of certain characteristic (Patton 1990), was adopted by sending out questionnaires to CWs who (1) are a qualified skillful workers in specific areas (e.g., bar bender and fixer, concreter, bamboo scaffolder, carpenter, metal worker, excavator, bricklayer, building service, etc.) and (2) work in the main streams (i.e., main contractor and subcontractor firms) in the construction industry in Hong Kong. The researchers obtained permission from management personnel of companies and industrial institutions to proceed with the data collection. Of the 500 distributed questionnaires, 142 were returned, representing a response rate of 28.4%. Most of the respondents were in the age groups of 41–50 years old (27.4%), 31–40 years old (24.2%), or 20–30 years old (24.2%). Of the respondents, 19% were older than 50, while only 4.8% were younger than 20. More than 80% of the respondents had education levels of secondary education or below. This reflects the fact that CWs in Hong Kong are generally middle-aged and have comparatively low education levels.

Questionnaire Development and Measurement

Due to the low education levels of CWs, the questionnaire survey was translated into Chinese (i.e., the mother tongue of local CWs in Hong Kong). Respondents were requested to answer the questionnaire based on their experience in a particular project they stated at the beginning of the survey. A *stressor* scale (items extracted from scales developed and adopted by Calnan et al. 2000, Gmelch 1982, Leung et al. 2007, 2009, and Sims et al. 1976 refer to Table 2) and *emotional stress* scale (items extracted from emotional exhaustion scale developed by Maslach et al. 1996, refer to Table 1) were included in the survey. Based on their experience in the particular project mentioned, respondents were asked to rate their levels of agreement with the statements given on a seven-point Likert scale, a scale ranging from 1 (strongly disagree) to 7 (strongly agree).

To determine *job stress*, discrepancies between respondents' actual and expected abilities on various dimensions (items extracted from job stress items developed by Gmelch 1982 and adopted by Leung et al. 2008a, refer to Table 1) were obtained. Based on the same particular project, respondents were asked to

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Table 1. Statements for the Two Types of Stress for CWs

Job stress	Expected ability		Actual ability		Alpha
1. The number of tasks	a) I have to do	___	b) I am capable of doing	___	0.785
2. The level of difficulty of my work	a) I have to deal with	___	b) I am capable of dealing with	___	
3. The quality of work	a) I have to do	___	b) I am capable of doing	___	
4. The responsibility of my work	a) I have to take	___	b) I am capable of handling	___	
5. The degree of complexity of work	a) I have to handle	___	b) I am capable of doing	___	
6. The degree of skill	a) I have to use	___	b) I am capable of using	___	
7. The amount of work	a) I have to do	___	b) I am capable of doing	___	
8. The number of people	a) I have to work with		b) I would like to work with		
Emotional stress					
1. I am fatigued in the morning as I face another day on the job.					0.920
2. I am used up at the end of the working day.					
3. I worry about work during my hour off.					
4. I am emotionally drained from my work.					

Note: Respondents were requested to rate their levels of expected abilities and actual abilities on the job stress statements on the scale ranging from 1 (none) to 7 (a great deal); respondents were requested to rate their levels of agreement with the emotional stress statements given on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

rate their (A) actual abilities and (B) expected abilities in the various dimensions (e.g., the number of tasks, the responsibility of work) on a scale ranging from 1 (none) to 7 (a great deal) (i.e., 1—none, 2—little, 3—some, 4—average, 5—a bit more than average, 6—a lot, and 7—a great deal). The overall job stress levels were then obtained by totaling the deviations between the ratings of (A) and (B).

Last, as a shorter reference period is desirable for obtaining a more accurate estimate (Landen and Hendrick 1995), the respondent CWs were asked to report the number of *injury incidents* they had in the same particular project during the two years prior to taking the survey, though the duration of the particular project may deviate. The measurement of incidents in this study covers all incidents the respondent had at work which have resulted in injuries.

Factor Identifications for Job Stress and Emotional Stress (Reliability Analysis)

The reliability levels of job stress and emotional stress were shown by Cronbach's α values (a commonly used indicator of internal consistency; Pallant 2001) of 0.785 and 0.920, respectively. As both of their α values were higher than 0.6, the two stress dimensions were considered reliable for further analyses (Hair et al. 1998).

Factor Identifications for Stressors (Factor Analysis and Reliability Analysis)

Based on the nature of CWs' jobs and on an extensive stress management literature review, stressors on CWs were categorized into five groups: task stressors, organizational stressors, personal stressors, interpersonal stressors, and physical stressors. These scales with item numbers of 9, 8, 6, 11, and 7, respectively, were subjected to principal factor analysis with varimax rotation (eigenvalue—1 cutoff) by spss version 11.0. With the sample size of 142, the sample-to-item ratios of these five categories of stressors were 16:1, 18:1, 24:1, 13:1, and 20:1, respectively, all higher than the ratio of 10:1 suggested by Nunnally and Bernstein (1994).

Twelve factors were resulted from the factor analysis, including work overload (S1), role ambiguity (S2), and lack of autonomy (S3) for task stressors; unfair reward and treatment (S4) and appropriate safety equipment (S5) for organizational stressors; type A behavior (S6) and optimism (S7) for personal stressors; interrole conflict (S8), poor workgroup relationship (S9), and lack of feedback (S10) for interpersonal stressors; and poor physical environment (S11) and unsafe environment (S12) for physical stressors (refer to Table 2). Items with factor loadings below 0.6 (i.e., s9, s20, s27, s28, and s34) and factors with Cronbach's α values under 0.6 (i.e., S6-type A behavior) were removed from the further analyses in order to ensure that items under the same factors are measuring the same underlying construct. All items loaded onto appropriate factors as predicted except s31 and s34, which loaded onto S9 and S10, with the original prediction being reversed. Perhaps good relationships within workgroups can encourage CWs to get feedback from their supervisors. S34 was removed from S10 due to the low reliability of the α value obtained. The items, factor loadings, and Cronbach's α values of the 12 factors are summarized in Table 2.

Correlation between Stressors, Stresses, and Injury Incident (Pearson's Correlation Analysis)

Based on the factors generated from the factor analyses, Pearson's correlation analyses were done to explore the interrelationships between the various stressors, the two types of stress (job stress and emotional stress), and CW injury incident (refer to Table 3). The squares of the two types of stress were also included in the analysis so as to explore their curvilinear relationships with injury incidents of CWs. The results indicate that job stress was correlated significantly with work overload (S1: 0.440), role ambiguity (S2: 0.318), unfair reward and treatment (S4: 0.329), interrole conflict (S8: 0.428), poor workgroup relationship (S9: −0.284), and unsafe environment (S12: 0.286). Emotional stress correlated significantly with all 11 stressors (S1: 0.684; S2: 0.542; S3: 0.424; S4: 0.614; S5: −0.395; S7: −0.287; S8: 0.637; S9: −0.379; S10: 0.342; S11: 0.378; and S12: 0.351). The CW injury incident was positively correlated with job stress (0.206), emotional stress (0.254), and the squared emotional stress (0.161). To ensure that there is no multicollinearity effect involved between

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Table 2. Scale Items, Factor Loadings, and Coefficient Alpha Reliabilities for the Stressors on CWs

Factors (stressors)	Nature	Items	Description	Factor loading	Alpha
			Task stressors		
S1 Work overload	+	s1	My job uses up most of my time to relax.	0.898	0.892
	+	s2	There is constant pressure to work all the time.	0.844	
	+	s3	I have a lot of responsibility in my job.	0.869	
S2 Role ambiguity	+	s4	My job responsibilities are generally vague, unclear, and inconsistent.	0.880	0.907
	+	s5	My goals and objectives are intangible and not clearly spelled out.	0.894	
	+	s6	Explanations of what has to be done are often unclear.	0.855	
S3 Lack of autonomy	+	s7	I have to refer matters upwards when I can really adequately deal with them myself.	0.798	0.607
	+	s8	My supervisor often deals with me in an autocratic and overly demanding manner.	0.695	
	+	*s9*	*I was given insufficient authority to do my job properly*	*0.580*	
			Organizational stressors		
S4 Unfair reward and treatment	+	s10	I find the reward I get is relatively low when compared to the external market.	0.893	0.909
	+	s11	I often feel that the organization treats us unfairly.	0.918	
	+	s12	I find the reward I get does not balance with the effort I put in.	0.916	
S5 Appropriate safety equipment	+	s13	Provision of safety equipment is sufficient.	0.898	0.963
	+	s14	Safety equipment is in good condition.	0.931	
	+	s15	Safety equipment is regularly checked.	0.940	
	+	s16	Safety equipment is under regular maintenance.	0.940	
	+	s17	Safety equipment is regularly replaced.	0.900	
			Personal stressors		
S6 Type A behavior	+	*s18*	*I am an achievement oriented person who has the need to win.*	*0.756*	*0.444*
	+	*s19*	*I enjoy competition and feel I always have to win.*	*0.839*	
	+	*s20*	*People sometimes say that I easily get temper.*	*0.568*	
S7 Optimism	+	s21	No despair with life and no life with despair.	0.900	0.913
	+	s22	I expect the best from life.	0.926	
	+	s23	I see the bright side of things.	0.926	
			Interpersonal stressors		
S8 Interrole conflict	+	s24	My devotion to work is usually in conflict with my devotion to family.	0.853	0.800
	+	s25	Family problems often concern me (e.g., trouble with children and marriage).	0.819	
	+	s26	My beliefs often conflict with those of the organization.	0.686	
	+	*s27*	*Things I do are often accepted by one person but not another.*	*0.550*	
	+	*s28*	*My family/friends would like me to spend more time with them.*	*0.449*	
S9 Poor workgroup relationship	−	s29	I have a good relationship with my supervisor.	0.875	0.760
	−	s30	My colleagues are trustworthy and friendly.	0.786	
	−	s31	I can get feedback from my supervisor on how well I'm doing.	0.750	
S10 Lack of feedback	+	s32	I have no opportunity to find out how well I am doing on my job (no prize, bonus, etc.).	0.868	0.832
	+	s33	It is hard to receive information about my job from my supervisor.	0.866	
	−	*s34*	*My colleagues more often compete with each other than cooperate with team spirit.*	*0.446*	
			Physical stressors		
S11 Poor physical environment	+	s35	Temperature is too extreme.	0.829	0.841
	+	s36	Air quality is poor.	0.907	
	+	s37	It is noisy.	0.885	
	+	s38	It is full of hazards.	0.647	

Table 2. (*Continued.*)

Factors (stressors)	Nature	Items	Description	Factor loading	Alpha
S12 Unsafe environment	−	s39	Equipment is placed in unorganized way.	0.716	0.753
	−	s40	Lighting is sufficient.	0.836	
	−	s41	Provision of indicator is sufficient.	0.884	

Note: All items were measured on a seven-point scale ranging from "disagree strongly" to "agree strongly." Kaiser-Meyer-Olkin=0.823 for task stressors, 0.839 for organizational stressors, 0.748 for personal stressors, 0.703 for interpersonal stressors, and 0.733 for physical stressors. %Variance explained is 76.123% for task stressors, 86.335% for organizational stressors, 73.146% for personal stressors, 64.024% for interpersonal stressors, and 71.740% for physical stressors. Indicated by italic lines, items with factor loadings under 0.60 or factors with Cronbach's α coefficients under 0.6 were deleted from the above data analysis.

the hypothetical variables, variance inflation factor (VIF) is obtained to diagnose the collinearity through the SPSS. The VIF figure higher than 10 represents a multicollinearity among the variables (Pallant 2001). The highest VIF value obtained in the current study is 3.16, thus, there is no multicollinearity problem among the variables.

Interdependent Relationships of Stressors, Stresses, and Injury Incident (Multiple Regression Analysis)

To conduct a more sophisticated exploration of the interdependent relationships between the various stressors, the two types of stress, and the injury incident of CWs, multiple regression analysis was further applied in the study, based on the result of correlation analysis. The result of Pearson's correlation indicated that stressors S1, S2, S4, S8, S9, and S12 were significantly related to job stress; that all of the stressors were significantly related to emotional stress; and that the two types of stress as well as the squares of emotional stress were significantly related to CW injury incident. Therefore, the relevant variables were selected as independent variables in the regression analyzes of job stress, emotional stress, and injury incident (refer to Models 1–3 in Table 4).

Model 1 revealed that the job stress of CWs was positively associated with work overload (S1), poor workgroup relationship (S9), and interrole conflict (S8), explaining 28.0% of the variance. Emotional stress was the dependent variable in Model 2 and was positively associated with poor physical environment (S11), work overload (S1), unfair reward and treatment (S4), and interrole conflict (S8), but negatively associated with appropriate safety equipment (S5), accounting for 62.5% of the variance. Last, to explore the linear and curvilinear interdependent relationships between the two types of stress and CW injury incident, Model 3 was developed with the two types of stress and the square of emotional stress as independent variables. The injury incident was positively predicted only by emotional stress, explaining 6.5% of the variance only. Perhaps, CW injury incident is also susceptible to variables other than stresses, such as the resourcing of projects, safety culture, and behaviors of CWs, factors that were beyond the scope of the current study. Further study should be done to more comprehensively investigate the variables leading to CW injury incidents. However, this model does confirm that CW injury incident is still significantly affected by emotional stress.

Discussion

Based on the results of the three regression models developed, a statistical stressors-stress-injury incident model was developed for CWs in Hong Kong and is illustrated in Fig. 2. Out of the two types of stresses and the squared emotional stress, only emotional stress predicted the injury incident of CWs. It was, simultaneously, affected by work overload, interrole conflict, poor physical environment, unfair reward and treatment, and appropriate safety equipments. Job stress was found to be predicted by poor workgroup relationship, work overload, and interrole conflict.

Table 3. Correlation between Stressors, Stresses, and Injury Incident of CWs

Factors	Job stress	Emotional stress	Job stress^2	Emotional stress^2
S1 Work overload	**0.440**[a]	**0.684**[a]	—	—
S2 Role ambiguity	0.318[a]	0.542[a]	—	—
S3 Lack of autonomy	0.098	0.424[a]	—	—
S4 Unfair reward and treatment	0.329[a]	**0.614**[a]	—	—
S5 Appropriate safety equipment	−0.109	**−0.395**[a]	—	—
S7 Optimism	−0.148	−0.287[a]	—	—
S8 Interrole conflict	**0.428**[a]	**0.637**[a]	—	—
S9 Poor workgroup relationship	**0.284**[a]	0.379[a]	—	—
S10 Lack of feedback	0.144	0.342[a]	—	—
S11 Poor physical environment	−0.044	**0.378**[a]	—	—
S12 Unsafe environment	0.286[a]	0.351[a]	—	—
Injury Incident	0.206[b]	**0.254**[a]	0.049	0.161[b]

Note: Correlation coefficient in bold: Interdependent relationships found in regression models (see Table 4).

[a]Correlation is significant at the 0.01 level (two-tailed).

[b]Correlation is significant at the 0.05 level (two-tailed).

Table 4. Regression Models of Stressors, Stresses, and Injury Incident of CWs

	Dependent variables	Independent variables						
Model	Stresses	← Stressors	Beta	t	Significance	R	R^2	Significance (ANOVA)
1	Job stress	(Constant)	−6.312	−1.582	0.116	0.529	0.280	0.000
		S1 Work overload	1.318	3.178	0.002			
		S9 Poor workgroup relationship	1.557	2.109	0.037			
		S8 Interrole conflict	1.094	2.655	0.009			
2	Emotional stress	(Constant)	0.640	1.154	0.251	0.791	0.625	0.000
		S11 Poor physical environment	0.168	2.395	0.018			
		S5 Appropriate safety equipment	−0.128	−2.270	0.025			
		S1 Work overload	0.374	5.244	0.000			
		S4 Unfair reward and treatment	0.224	3.157	0.002			
		S8 Interrole conflict	0.203	2.657	0.009			
	Injury incident	← Stress and stress^2						
3	Injury Incident	(Constant)	0.005	0.014	0.989	0.254	0.065	0.003
		Emotional stress	0.242	3.075	0.003			

Emotional Stress and CW Injury Incident

No curvilinear relationship was found between emotional stress and CW injury incident. Instead, the study indicated that CW injury incident was predicted positively by emotional stress (refer to Table 4). Individual CWs who suffer from emotional stress may exhibit poor safety behaviors (i.e., focusing less on safety compliance, precautions, and procedures), leading to a higher injury incident risk (Murray et al. 1997). Thus, based on the result of current study that CW's emotional stress predicts their injury incidents, to minimize their injury incidents, their emotional stress levels should be minimized.

Various Stressors Predicting Emotional Stress

Work overload has long been recognized as the prime determinant of emotional stress (Cordes and Dougherty 1993; Leung et al. 2008b). The dynamic nature of the construction industry and the demanding nature of CWs' jobs not only require huge amounts of physical vigor from CWs but also force them to work for unstable and long hours or sometimes even to work on evenings, weekends, and holidays to finish a job or to respond to an emergency; this is especially true for jobs that need special government approval due to public nuisances they cause (U.S. Department of Labor 2007). Such conditions can be frustrating and emotionally taxing, affecting CWs' energy on the job.

Although CWs normally work on a single project at a time, construction projects are always implemented under tight and urgent time frames. It is common for CWs to work overtime on-site. Excessive work demands lead to conflict in the performances of individuals' other roles (Lu et al. 2008) (e.g., their role as a father), in terms of the time, energy, and commitment they devote to other people (e.g., working overtime means they have less time to spend with their family, taking a rest after an exhausting work day means they may not get around to playing with their children, etc.). The *interrole conflict* that arises from CWs' different roles limited their time spending on releasing their emotions through seeking social support from their family and friends, thus, resulting in emotional stress.

Every working day, CWs are required to work in *poor on-site physical environments* with conditions such as extreme temperature (outdoor jobs), poor air quality (suspended dust), and excessive noise (operation of plants or from piling) (Burkhart et al. 1992). Poor work environment can affect individuals' emotional health, and, thus, results in anxiety and strain (Leung et al. 2007, 2008a, 2009; Sutherland and Cooper 1993). In fact, working under poor physical environment does not only lead to emotional stress, but can also induce absenteeism and higher staff turnover rate (Gmelch 1982).

CWs, temporarily performing jobs on-site and having little authority over construction projects, have only limited control

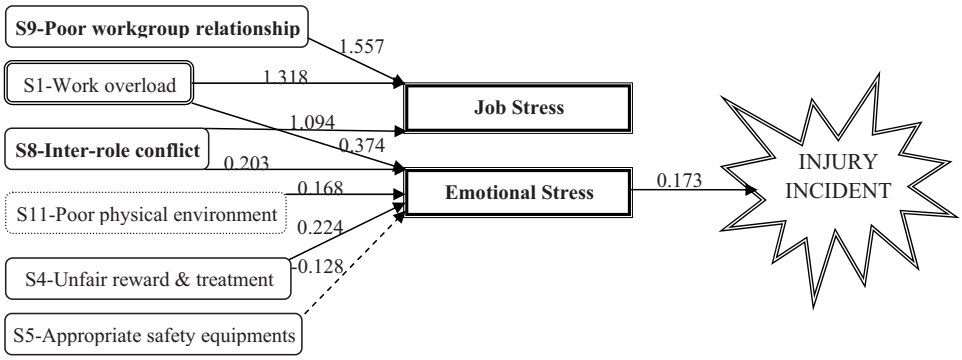

Fig. 2. Integrated stressors-stress-injury incident statistical model for CWs

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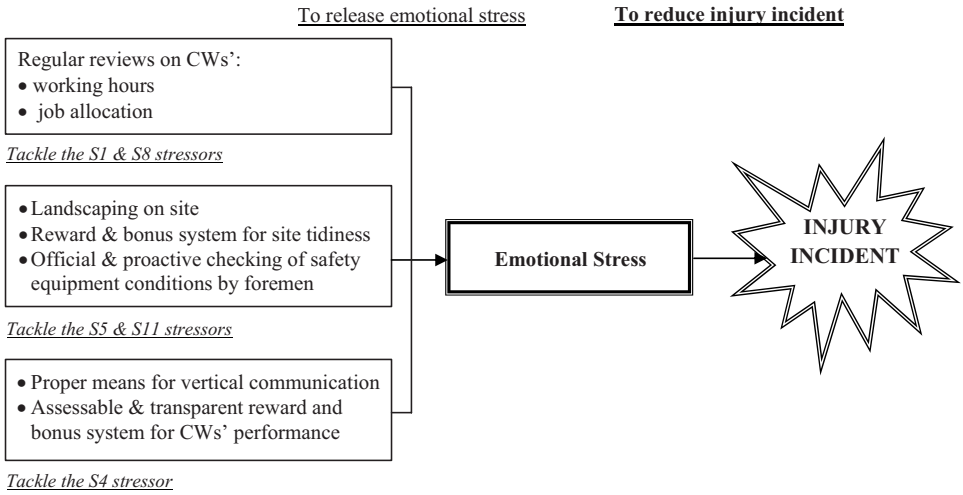

Fig. 3. Recommendations to reduce injury incident of CWs based on the study results

over the fairness of their *rewards and treatment* in terms of salary reasonability, working hours, and labor welfare (Stattin and Jarvholm 2005; The Standard 2007). When individuals perceive an imbalance between the rewards they receive and the effort they put in, their motivation for performing the work decreases and it is easier to generate emotional stress in practice (Cordes and Dougherty 1993).

On the other hand, the provision of *appropriate safety equipments* was found to have alleviating effect on the emotional stress of CWs. In fact, it is the responsibility of employers to provide sufficient safety equipments with regular maintenance. However, the project budget on safety is always prioritized as the first item to be cut under the competitive bidding (Hinze 1988, Zou et al. 2007). Working on a site with sufficient safety equipments do not only smoothen the work process of CWs, but also enhance the confidence and the sense of belongingness of CWs toward their company. CWs working under such a caring organizational climate would have lesser chance to suffer from emotional exhaustion (MacDavitt et al. 2007).

Various Stressors Predicting Job Stress

Although the current study reveals no significant relationship between the job stress and the CW injury incident in the industry, the impact of job stress on task performance and on sense of belonging has been confirmed in regard to construction professionals (Leung et al. 2008a). In the study, job stress is defined as the deviation between the expected and the actual ability of individual. Construction work tasks are well known to be exacting and tiring. Hence, CWs are often exhausted by their jobs and as a result have less concern, energy, and time for social communication with their colleagues. In fact, it is easy for an individual to perceive self-inability when he/she faces highly demanding expectations from his or her supervisor and foreman, and has little social support from others. The current study confirmed that *work overload* and *poor workgroup relationship* both act as predictors of job stress.

As construction projects are productivity-oriented, CWs are often urged for high effectiveness and efficiency on physically and technically demanding tasks that they are forced to take shortcut sometimes (Mitropoulos et al. 2005). However, being a responsible man to their family members, CWs do not only need to work diligently, but also have to take good care of themselves at work (e.g., work steps by steps to prevent dangers). Hence, the *interrole conflict* that arises from CWs' different roles may affect their work performance and, thus, results in job stress.

Recommendations

The findings of the current research provide an important insight into how to reduce CW injury incidents. Emotion health of the individuals is of key concern, as the emotional stress acts as the key predictor of injury incident of CWs. This implies that CWs injury incident can be reduced once their emotional stress is reduced. To prevent CWs from suffering emotional stress, attention should be paid on the various stressors leading to it, including work overload, interrole conflict, poor physical environment, appropriate safety equipments, and unfair reward and treatment. Hence, a number of recommendations can be made in relation to different stressors predicting emotional stress, which further predicts injury incidents of CWs (see Fig. 3).

As suggested by the study result, to alleviate CWs' emotional stress, their work overload and interrole conflict level should be lowered. In fact, long working hours, which would further lead to higher work-family conflict, have been proved to affect the psychological well-being of CWs in Australia (Lingard et al. 2006) and the general employees (Burke and Cooper 2008). Hence, the employers are suggested to *review the working hours* and the *job allocated* to CWs. However, this does not necessarily mean reducing the working hours of CWs. Employers can consider giving an extra hour during lunch to keep CWs away from the sun and extending one hour in the evening. It actually can also reduce the chances of CWs succumbing to heatstroke during the summer (The Standard 2007).

The results reveal that poor physical environment and inappropriate safety equipments have influence on CWs' emotion. Although construction work is notorious with its poor working condition, employers should still put effort on *enhancing the physical environment* and *maintaining safety equipments in good condition* to CWs. As adverse working environment, such as foul air, chaos area, and excessive noise, would produce negative impact on emotion of human beings (Lee et al. 2008; Rhud 2001),

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employers are suggested to green the site to enhance the air quality (e.g., plant trees around the site, especially near the site office so that CWs, together with other construction professionals, can enjoy it when they have site meetings or take rest), encourage CWs to allocate all miscellaneous tidily through a reward and bonus system. In addition, instead of the existing practice of regular checking taking out by safety officers/supervisors (i.e., corrective acts), stakeholders are recommended to assign foremen to, officially, check and keep record on the applications and conditions of all safety equipments every time before they assign works to CWs (i.e., proactive acts).

The next recommendation for minimizing CW injury incident is to deal with the unfair rewards and treatment CWs receive and thereby reduce their emotional stress. The large power divide between employers and employees is especially obvious in the construction industry, as the social and industrial statuses of CWs are often low. CWs are not able to express their needs, leading ultimately to unfair rewards and treatment. In view of this fact, employers are encouraged to provide *proper means of vertical communication* with CWs, which can either be formal or informal (e.g., Master Lu Ban Festival company dinner or regular workgroup meetings). An *assessable and transparent reward and bonus system* is recommended in order to encourage quality task and safety performance of CWs (Nielsen 2007). In this way, CWs can have a direct and concrete path for pursuing their rewards, while employers can simultaneously be benefited through the higher productivity of CWs, resulting in a win-win situation.

Further Research

In the current study, three regression models were developed to explore the relationships between the three dependent variables (i.e., job stress, emotional stress, and injury incident) and various sets of independent variables. R square values were obtained to explain the percentage of variance in the three dependent variables. The R square value of Model 3 is comparatively low. This result reveals that, besides the two types of stress identified in the present study, there may be other independent variables that predict CW injury incident (e.g., the resourcing of projects, the safety training and culture of the organization, the individual safety behaviors of CWs, etc.). It is recommended that these factors can be investigated in the further studies to explain the CW injury incident.

This study adopted a self-reporting survey measurement method. Therefore, the findings may have the potential risk of common method variance and the validity of data may be questioned. It would be ideal to also obtain objective data of the various variables (e.g., number of working hours, physiological indicators of stress levels, injury incident records from the organizations, etc.) for cross-validation of the subjective data in further study. However, it should be noted that the scales used in this study were adopted from the extensive stress management and construction safety literature. In addition, the respondents of this study were all CWs in Hong Kong who had direct experience with on-site construction operation.

The current research, which was done using quantitative methods based on a relatively small sample size, provides a foundation exploration of the relationships between various stressors, stresses, and injury incidents of CWs in the construction industry. Quantitative methods attempt precise measurement of variables, while qualitative methods aim at seeking how and why things happen (Cooper and Schindler 2006). Although qualitative methods have been available much longer in sociology and psychology historically (Kopala and Suzuki 1999), quantitative research methods were adopted in the current study as the aim of the current research is to explain and predict the relationships between various variables identified (Cooper and Schindler 2006). To achieve an in-depth understanding of the relationships between these variables, it is recommended that qualitative research methods, such as personal interviews and case studies, be used for further research and act as a cross-validation of the foundation result of the current study (triangulation method).

Conclusions

Construction work has long been recognized as a stressful and dangerous occupation wherein stress levels and injury incidents of CWs are always high. In view of this issue, the current study has aimed to identify the various stressors leading to CW stress as well as to investigate the impacts of stress on CW injury incident. The current study identified 11 sources of stress, including work overload, role ambiguity, lack of autonomy, unfair rewards and treatment, appropriate safety equipment, optimism, interrole conflict, poor workgroup relationship, lack of feedback, poor physical environment, and unsafe environment. The study also identified two types of stress: job stress (i.e., the difference between CWs' expected and actual abilities at various tasks) and emotional stress (i.e., the emotional fatigue of individuals, resulting from chronically stressful conditions).

The findings revealed that CW injury incident is mainly affected by emotional stress (positive linear). Emotional stress can be predicted by work overload, interrole conflict, poor physical environment, unfair reward and treatment, and appropriate safety equipment. Job stress is predicted by poor workgroup relationship, work overload, and interrole conflict.

In order to minimize the CW injury incident by controlling the stressors that lead to emotional stress, the study indicated the importance of regularly reviewing the working hours and job allocation of CWs and of ensuring the presence of proper physical working environments and proper safety equipment for CWs onsites. On the other hand, it is recommended that employers enable proper vertical communication channels with CWs and devise assessable and transparent bonus systems for CWs. Although CW injury incident may be influenced by other factors not examined here, the results of this study still clearly indicate the significant impact of CW emotional stress on CW injury incident. It is recommended that individual safety coping behaviors and organizational strategies be further studied in order to understand the impacts of stress on the actual safety behavior of CWs and to identify the primary source factors for safety and stress management in the industry. It is recommended that further qualitative studies can be done to cross-validate the results in the current study.

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