

Analysis of the case of fire fighters casualties in the building collapse

Ru Kang^{a,b,*}, Gui Fu^a, Jun Yan^c

^a*School of Resource and Safety Engineering, China University of Mining & Technology (Beijing), Beijing 100083, China*

^b*Department of fire protection engineering, Chinese People's Armed Police Forces Academy, Hebei Langfang 065000, China*

^c*Department of Piping engineering, Pipeline Institute Hebei Langfang 065000, China*

Abstract

Using the "2-4" model of behavior safety to study the cause of the fire fighters sacrifice caused by the building collapse since 2003, the direct cause of deaths lies in unsafe act and the unsafe state of the material. To analyze further, the lack of safety knowledge and weak safety awareness, the lack of safety habits is the remote cause of the casualties, the fire brigade's security management system is the primary cause of some problems, the construction of fire safety culture is the root cause. The focus on fire prevention and investigation, and improvement of the system of full-time security staff, the establishment of a unified system of fire accident investigation, the implementation of the disposal of the program to prevent such incidents from happening again were put forward in this article.

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1. Preface

According to the data statistics, hazards endangering the fire fighters life safety can be divided into seven categories, namely: the collapse of the building, explosion (deflagration) or flashover, fall or drop, electric shock, gas poisoning, traffic accident and other accidents. Building collapse, explosion (deflagration) or flashover caused the most serious firefighters sacrifice, accounting for 73%, and firefighters sacrifice due to building collapse accounted for more than 36% of the total number of sacrifice [1]. Building collapse in the fire has the characteristics of a suddenness, strong destructive, large casualties and personnel evacuation difficulty. It is experienced that the general material volume exceeds the building capacity of 1/3, building fire resistance rating of two, long burning time is easy to collapse.

How to avoid and reduce the fire fighters sacrifice has been the focus of the fire fighting forces. Through the analysis of the fire fighters sacrifice cases which had been caused by the building collapse since 2003, the direct cause of the accident is concluded using the "2-4" model, and the indirect cause, primary cause (the management system) and root cause (fire safety culture) are also put forward. Thus in order to prevent similar tragedies the effective and reasonable accident prevention route was presented on these grounds.

2. Interpretation of the accident cause by using the "2-4" behavioral safety model

2.1. Case analysis

Through the review of *China Fire Yearbook* [2-7] in recent years and news report about fire fighters casualties caused

* Corresponding author. Tel.: +86-316-2069387; +86-15930614169

E-mail address: kangru2011@163.com

by the building collapse since 2003, the accidents were counted. The direct cause of 17 accidents was found including persons unsafe act and unsafe state of material. Unsafe act mainly refers to fatigue operation, not alert to the scene changes, blind operation, (risk operation), personal protective equipment is not dressed as required, inadequate or lack of protective measures, no safe place to take emergency measures, in unsafe position. Unsafe state of material mainly refers to building fire over time, the large fire load, unclear fire scene.

From the collapsed buildings, there are several circumstances, a: the burning time of construction surpass the fire resistance or building load surpass its load capacity causes the whole building collapse and causes fire fighters casualties, such as case2、3、4、16、17; b: roof truss structure by the flame high temperature lose ability to support and collapsed ---roof or ceiling collapsed, give rise to fire fighters death, as the example of case 8、14、15; c: the wall is caused by a high thermal expansion or an external force to cause a collapse accident, give rise to fire fighters death, for example case1、5、9、10; d: due to the inherent cause of building structure design or construction materials in high temperature bearing lose, induced by beam or girder collapse, give rise to fire fighters death, for example case 6、7、11、12、13. Forty seven firefighters were killed and sixty one man were injured in 17 accidents---huge casualties.

The National Standard Technology Agency (NIST) and the Phoenix Fire Department said that the general lightweight framework of residential buildings from the fire to the roof collapse is less than 20min, without any warning. Although the fire fighter training tells them that their own safety is very necessary, they are unable to predict the safety operation time, often cannot choose to evacuate. Time provided by Specifications is only mechanical data, it is difficult to effectively reflect the actual fire safety time, the collapse is often not any omen occurs quickly, and firefighters completely unaware that they are in danger [8].

Table 1. The fire fighters casualty cases caused by building collapse

Number	Time	Casualty figure	Accident process	Unsafe act
1	2015-2-24	1dead	Farmer house fire at Xiaofeng Village Muyun Country Fu'an City, the houses wall was collapsed, suddenly a fireman died	Not alert to the scene changes (protective measures are not in place)
2	2015-1-2	5dead 14injured	Warehouse fire at North Nanxun ceramics market, 11 story building collapsed, 5 firefighters were killed	Not alert to the scene changes (the building has been in fire over 2 hours)
3	2014-2-4	2 Dead 2injured	A plant fire at Minke Road Baoshan District , the fire plant suddenly collapsed when the fire was soon to be extinguished, resulting in two soldiers buried	Not alert to the scene changes (in an unsafe place, the factory has been in fire over 2 hours)
4	2013-10-12	2dead	Xilongduo shopping mall fire at Pingguoyuan South Road Shijingshan District, due to the rapid spread of the fire building suddenly collapsed, two fireman died	Fatigue operation (failed to find the signs in time)
5	2013-2-25	1dead 1injured	Houses fire at Chenbu village Wuyang Town Ruijin City , in the course of fighting, soldiers were buried by the collapsed walls	Personal protective equipment is not worn as required (the helmet is hit by a brick)
6	2012-10-7	1dead	Six stores burst fire at Heshan Road Xingbin District Laibin City, in the rescue operations soldier was hit by collapsed beam above the pull gate	Not alert to the scene changes (protective measures are not in place)
7	2012-2-1	1dead 1injured	Ting Xin Jie Dayun Precision Co. Ltd. fire at Suzhou Industrial Park, in further search and rescue process, the soldiers were hit by storage rack and unfortunately inhaled excessive smoke and choked	Personal protective equipment is not worn as required (the safety rope was buried pressure, the SCBA alarm,but firemen did not withdraw)
8	2011-2-6	1dead 2injured	A two-story brick structure houses fire at Langtian Village Zuolong Town Ji'an City, in the process of fire, fire building suddenly collapsed, three soldiers were buried	Not alert to the scene changes (Housing fire overtime)
9	2010-4-7	1dead 2injured	Xincheng Plastic Co. Ltd fire at Yanggu City Shandong Province, in the process of fire, the wall suddenly collapsed, firefighters in the combat were unfortunately hit	Not alert to the scene changes (factory fire overtime)
10	2008-07-21	1dead	A furniture factory fire at Longjiang Town Shibei Development Zone, the wall on the west side of the factory suddenly collapsed when they cleaned up the scene of the fire , the fireman was suppressed	Not alert to the scene changes ((protective measures are not in place,no time to escape)
11	2008-7-17	3dead 9injured	IKEA plastic factory warehouse fire in the suburbs of Shanghai Fengxian District, a serious hidden danger of the building structure of the 50 meter main beam suddenly collapsed, resulting in a number of firefighters pressed	Personal protective equipment is not worn as required (Smoked down)
12	2007-10-8	2dead 5injured	The scaffold hanging collapsed in the construction of elevated plant on the south side at Wifu Thermal Technology	Blind operation (regardless of danger, rushed into the collapse site,

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