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Role of Architects in Building Disaster Resilient Communities

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Abstract
Earthquake is a natural phenomenon occurring with all uncertainties. It is one of the most devastating forces in nature which has challenged the current built environment. Many buildings have remained vulnerable to the effects of ecological worsening and an ever more commodified environment. These challenges can be overcome only by making better, smarter and in more resilient ways. There is a need for promoting the concept of resilience in architecture through learning and advanced research and development. These prevailing challenges has increased the role of architects in creating resilient communities. The objective of this research is to identify the role of architects in creating the building as well as the quality of resilient communities in a variety of contexts at national, regional or global level. Since this study adopted a qualitative research, the interpretive model was applied to investigate the research problems. This study used the Case Study method, a common way for carrying out qualitative research, to guide the research process. These case studies shed light on the role of architects in building disaster resilient communities. Conclusions serve as a new concept to future researchers in this field and all the related stakeholders and creates professional strategies for improvement of building and community as a whole.

Keywords
Architects-Role - Responsibility - Resilience - Communities - Built environment

1. Introduction

Natural disasters such as earthquakes, landslides, forest fires, hurricanes, oil spills, and floods are a source of high economic, environmental and human impact. Every year, thousands of human lives are lost, millions of people bear the destruction of their homes and an invaluable economic harm is made. It has been estimated that a new big disaster arises every three days, whereas local and regional authorities must manage the thousands of emergencies that take place every year. These two definitions encompass both man-made and natural disasters including earthquakes, hurricanes, war, floods, civil disturbances and riots, nuclear accidents, landslides, economic depression or disinvestment, plane crashes, and even some urban renewal projects. In a more basic sense, a disaster is an event that causes destruction to the built environment—the places in which humans live, work, and recreate. Just as quickly as people build roads, buildings, and parks, there are forces such as wind, hail, economics, and political conflicts that destroy them. Obviously, emergency management focuses on saving human lives and decreasing economic losses. Nowadays, these objectives are reachable due to the technological revolution that has taken place during the recent years in research areas like computing, telecommunications, computer networks, remote sensing and global positioning. In particular, the appearance of the sensor web enables the sharing of a wide variety of observations from spatially referenced sensors into a distributed computing network. As a result of the integration of these technologies, quick and automatic alert and characterization of disasters is now achievable. However, the lack of preventive planning and design both before the disaster and afterward is a critical problem with which the design world has only slowly been facing.[1]

Following the Indian Ocean tsunami in 2004, which killed more than 200,000 people, the first questions were asked about the role and responsibility of architects in disaster risk management. A succession of disasters like the 2008 earthquake in Sichuan province, China, and the 2010 earthquake near Port-au-Prince, Haiti, have offered urgent reminders that professional architects whether in the developing or developed world are generally absent from efforts to protect people from disaster. They have had no sustained role in shaping policy or leading best practices in disaster prevention, mitigation, and recovery. There is still no career path that prepares students to work as design professionals who intervene at a crucial moment in the recovery process to produce enduring solutions. Architects have been slow to respond to the needs of disaster management but there is a growing engagement. In recent years, a handful of professionals in small agencies or scattered through larger firms have helped to introduce innovative and sustainable building methods, land-use planning, and environmental stewardship to disaster zones. A common ideology has emerged on how to bridge the gap between short-term emergency needs and long-term sustainable recovery. [1]

Architects and the construction industry have a significant role in the health and safety of the environment and in disaster management. Their role includes a range of activities designed to maintain control over emergency situations, providing a framework for helping those who are at risk to avoid or recover from the impact of the disaster. FEMA [1] recognizes both as unfilled roles, stating "the literature on natural hazard mitigation directed toward the architectural profession is scarce in spite of the fact that architects can make a significant contribution to hazard risk reduction". Communities can prepare themselves for potential disasters and mitigate or reduce the impact of hazards so that they will not have to rebuild their homes and businesses. When risks are addressed ahead of time, the potential for damage will decrease. As expressed by FEMA, "mitigation has long been perceived and practiced as an essential tool for helping to save lives, reduce property damage, and decrease the money spent on disaster recovery efforts." Informed and trained architects can be advocates for increased public education and awareness by conveying the risks owners face and demonstrating how those risks can be reduced through specific building mitigation methods.[1]

1.1 Need of Research

Since architecture and disaster management are seldom linked in literature or in practice- the scope of the former in the latter is often overlooked. Nonetheless, if the stages were dealt with further scrutiny it can be asserted that it is the architect's capacity only to work within a process to come up with a sustainable solution rather than only a product during certain stages of the DM [2]cycle (pre-disaster preparedness and post disaster recovery and reconstruction phases). Architects can play a vital role as an activist but the problem is, of architects focused on resilient building, are not integrally involved with communities who are suffering with hazards. Architectural designs should accommodate earthquake studies and considerations, urban design in populous areas should consider the need to prevent the spread of fires, diseases.

1.2 Research Design and Methodology

In this research, qualitative approach is used to explore, analyse and understand the perceptions of both experts and people regarding the role of architects in building disaster resilient communities. The research consists of four phases:

- First phase: finalize the proposal that identifies the problem and establishment of the objectives of the study and development of research plan.
- Second phase: includes comprehensive literature review for identifying the role of architects in building resilient communities taking case studies of Gorkha earthquake and works of Architect Shigeru Ban
- Third phase: Semi-structured interview with different architects
- Fourth phase: includes conclusions and recommendations.

2. Role of Architect

According to UNISDR [3] 2017, the term resilience is defined as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management. Resilient development practices integrate various aspects such as-

[1] Federal Emergency Management Agency

[2] Disaster Management

[3] United Nations Office for Disaster Risk Reduction

- Disaster Risk Reduction
- Recovery
- Social risk reduction
- Sustainable livelihoods approach
- Climate change adaption
- Ecosystem management
- Good governance

The architects' job is to understand the complex needs of client and users of building projects and, in collaboration with multidisciplinary teams, to develop and realise designs based on these. [2] However, in case of disasters, architects' role may vary in various stages of the disaster.

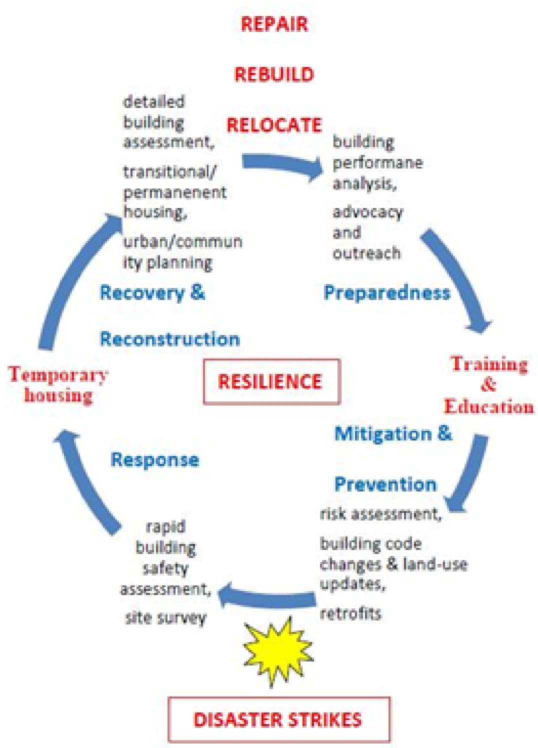

Figure 1: The role of an architect in DRM cycle

2.1 In pre-disaster and during impact:

Following a disaster, infrastructure and households are greatly damaged along with settlements due to unplanned development. Hence, architects should be entitled with the task of recognizing the previous flaws in building codes and policies, urban design and infrastructure and perform damage assessments as it is their forte. A team of architects can complete such tasks of assessing damage and planning for reconstruction in a few days resulting in smooth flow of activities and of course timely assistance. This increased capacity allows residents to return more quickly and safely to their homes and work.[3]

2.2 In Post Disaster Reconstruction:

During this phase, the architect's role best fit into the reconstruction and restoration activities and they have a momentous role to play.Studies have highlighted that majority of NGOs [4] lack an understanding of the complexities of post-disaster housing, and fail to link post-disaster housing to the local building process. As a consequence, such projects continue to fail culturally and technically. It is the architects only that possess the rigorous understanding of how to structure the human habitat. [4] Post-disaster reconstruction involves more than the rebuilding of damaged and destroyed structures and entire towns. It is an opportunity to create new designs and use improved construction techniques and materials to build stronger and sustainable structures.

3. Policies for the architects' involvement in building resilient communities after the disaster

3.1 FEMA

The Federal Emergency Management Agency's publication, "Planning for Post-Disaster Recovery and Reconstruction" (FEMA 421), introduces community planners to policies for rebuilding and recovery after disasters and provides guidance on how to plan for post-disaster reconstruction.This document equips planners and others involved in post-disaster reconstruction at all levels of government with the tools needed to create or re-create communities that will withstand natural disasters.[5]

3.2 AMERICAN INSTITUTE OF ARCHITECTS

The AIA's "Disaster Assistance Handbook," published in March 2017, is a go-to resource for architects, built environments professionals, municipal government officials and emergency managers involved in disaster mitigation, preparation, response, and recovery. Developed by a national team of AIA members and staff, alongside contributions from industry experts

[4]Non-Governmental Organization

and government officials, the handbook is oriented towards using architects' existing skill set to address different phases of a disaster.

3.3 Post-Disaster Recovery Framework (PDRF), Nepal

The Post-Disaster Recovery Framework (PDRF) was prepared under the leadership of the NRA, in consultation with key stakeholders, to provide a systematic, structured and prioritized framework for implementing recovery and re-construction.[6]

This is a common framework meant to serve all of government, as well as national and international partners and other recovery stakeholders, including the affected population. The involvement of development partners and stakeholders has created opportunities to highlight key challenges and constraints and to emphasise the need to align the priorities and programmes of key stakeholders. However, the individual roles of the stakeholders including the architects and planners have not been specified in PDRF. This has become a major challenge in building disaster resilient communities after the occurrence of any disasters. The critical involvement of building industry professionals such as architects, planners and surveyors have been overlooked while developing the standards and guidelines.

4. Case Studies

There are plenty of notable works around the globe showing the architect's role in disaster management and in building disaster resilient communities. Architects have responded to disasters over past centuries- from the five different plans to rebuild London after the Great Fire to Japanese architect Shiegru Ban's latest effort to create housing for Nepal's earthquake survivors using rubble and recycled cardboard. Some of the key projects showcasing the role of architects in the world's best disaster relief projects are listed below

4.1 The Women's Centre, Darya Khan, Pakistan, designed by Yasmeen Lari in 2011

Pakistani architect Yasmeen Lari, 75, has built over 36,000 homes for flood and earthquake victims in her home country since 2010. Lari's organisation, the Heritage Foundation of Pakistan, employs architecture students to train local residents to build more resilient homes using local materials like bamboo and mud. She uses ancient architectural traditions and teaches the people in villages to rebuild their own houses. Lari is particularly concerned with addressing the needs of women, who are disproportionally effected by natural disasters because they are usually the carers of children and providers of food. [7]

Figure 2: The Women's Center by Yasmeen Lari

4.2 Shigeru Bans Architects

The Japanese architect and Pritzker Prize laureate, Shigeru Ban, is best known for his humanitarian work, where he plays an important part of disaster relief work. Ban pioneered the idea of using paper and cardboard to design high-quality, low-cost shelters for victims of natural disasters around the world. This concept of housing follows the open prefabricated system that reaps the benefits of being inexpensive, easy to construct, modifiable, and involve the participation of the community. A sample of Ban's most noteworthy disaster relief projects are:

4.2.1 Cardboard Cathedral

Cardboard Cathedral, built in 2013, gave the community of Christchurch, New Zealand, a new symbol of strength following the 2011 earthquake that destroyed the city's beloved 19th century Anglican church.[8]

Figure 3: Cardboard Cathedral, New Zealand

4.2.2 Hualin Temporary Elementary School, Chengdu, China, 2008

To aid the reconstruction of the city after the earthquake in May 2008, Shigeru Ban's research centre, banlab, collaborated with several Japanese and Chinese universities to design and construct temporary classrooms constructed from paper tubes for the Hualin Elementary School.These were the first buildings in China to have a paper-tube structure, and were also the first school buildings to be rebuilt in the earthquake-stricken area.[8]

Figure 4: Hualin Temporary Elementary School, Chengdu, China

4.2.3 Krinda House

Kirinda is a small Muslim fishing Village, in Srilanka affected by Indian Ocean Tsunami on December, 2004 The Area has a tropical climate with high humidity and very little seasonal variation on Temperature. Typical local architecture includes single storey detached construction of composed of concrete blocks, corrugated iron roof sheeting and timber. The houses were designed to allow maximum cross ventilation. Slatted upper walls at the gable ends, the open court space in the middle of the building.The open court space in the middle of the building was designed to provide a shaded, ventilated area where inhabitants could carry out various important functions, such as eating, socializing and repairing fishing nets and other equipment.[8]

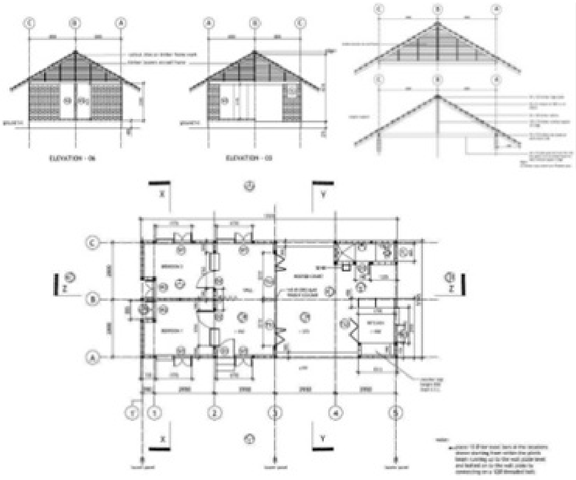

Figure 5: Krinda House, Srilanka

4.2.4 Onagawa Container Temporary Housing, Miyagi, Japan, 2011

The town of Onagawa in Miyagi Prefecture suffered extreme damage from the earthquake and tsunami on March 11, 2011. Architect Shigeru Ban responded by designing a multi-story temporary housing complex for survivors. A three-storey structural framework was built to allow the stacking of 20-foot shipping containers in a checkerboard fashion. This alternating arrangement allows for airy and open living spaces with built-in shelves and closets for storage, a missing element within the temporary houses issued by the government.[8]

Figure 6: Onagawa Container, Miyagi, Japan

4.2.5 Paper Log House

The Paper Log House relief projects, designed for Japan, Turkey, and India—following earthquakes in 1995, 1999, and 2001, respectively—make use of water-resistant paper tube. The foundation consists of donated beer crates loaded with sandbags. The walls are made from 106mm diameter, 4mm thick paper tubes, with tenting material for the roof. The 1.8m space between houses was used as a common area. For insulation, a waterproof sponge tape backed with adhesive is sandwiched between the paper tubes of the walls. The cost of materials for one 52 square meter unit is below 2000 dollars. The unit are easy to dismantle, and the materials easily disposed or recycled.[8]

Figure 7: Paper Log House, Japan

4.3 In case of Nepal: Gorkha Earthquake, 2015

The devastating earthquake of 7.8 in Richter scale that struck the country with its epicenter at Mandre, Barpak VDC-02, Gorkha at 11:56 am on 2072 Baisakh 12 (corresponding to 25 April 2015) and its frequent aftershocks chiefly the two fatal ones dated 26 April and 12 May 2015 have caused an inconceivable loss of lives and properties. Thousands of people have been killed, thousands injured and hundreds of thousands of houses completely destroyed and many people rendered homeless. Many government and public office buildings, historical, cultural and archeological heritages have been destroyed; physical infrastructures including public and private school buildings, bridges, roads, etc. have also been destroyed. The Government has declared the fourteen districts (Gorkha, Kavrepalanchok, Dhading, Nuwakot, Rasuwa, Sindupalchok, Dolakha, Ramechhap, Okhaldunga, Makwanpur, Sindhuli, Kathmandu, Bhaktapur and Lalitpur) as the crisis-hit districts and started rescue and relief works. In view of such a large scale of devastation, the Government of Nepal has taken various initiatives for rescue, relief and rehabilitation as well as reconstruction works. [9]

4.3.1 Design Catalogue for Reconstruction of Earthquake-resistant Houses Volume 1

The government of Nepal prescribed 17 earthquake -resistant house prototypes in the Design Catalogue for Reconstruction of Earthquake-resistant Houses, in order to start the construction of quake ravaged homes. It was published by the Department of Urban Development and Building Construction (DUDBC). This catalogue provides complete technical details, with 3D views of the design, floor plan, elevation and sections, for constructing the houses with varying costs, sizes, layouts and typology. Four different building typologies are included in the catalogue and they are: stone in mud mortar masonry, brick in mud mortar masonry, stone in cement mortar masonry and brick in cement mortar masonry. The number of manpower days for skilled and unskilled labour, as well as the quantity of materials required for the construction of the design, is also provided and divided in terms of requirements to construct up to the plinth level, up to ring beam level and for the construction of the roof. [10]

Figure 8: Housing Typologies in DUDBC Catalogue

4.3.2 Design Catalogue for Reconstruction of Earthquake-resistant Houses Volume 2

The second volume introduced 12 alternative materials and technologies with a view to contribute to sustainable reconstruction of both urban and rural houses through cost-efficient, environment-friendly and green technologies.The model designs of seventeen houses provided in the catalogue are placed under the following twelve technologies: i.Interlocking Brick Masonry, ii.Confined Hollow Concrete Block Masonry, iii.Hollow Concrete Block Masonry, iv.Compressed Stabilized Earth Block Masonry, v.Random Rubble Masonry with GI Wire Containment, vi.Bamboo and Stone Masonry Hybrid Structure, vii.Rat Trap Bond Masonry, viii.Earth Bag Masonry, ix.Light Gauge Steel Structure, x.Steel Structure, xi.Timber Structure, xii.Debris block Masonry

Figure 9: Housing Typologies in DUDBC Catalogue Volume 2

4.4 Housing designed for earthquake victims designed by Shigeru Ban

Pritzker Prize-winning architect and champion of disaster-relief architecture Shigeru Ban developed a prototype housing structure for the victims based on housing on traditional Nepalese houses that had survived the earthquake. Wooden frames provide the structure, the roof is built using a truss system of cardboard tubes, rubble is used to infill the walls, while thatch and plastic sheeting covers the roof.

Figure 10: Prototype by Shigeru Ban

4.4.1 Demo house by SONA

Society of Nepalese Architects along with SLTDC [5] had proposed to construct a demonstration building in Kathmandu so that people will be informed about the innovative technology for utilizing in the construction of their own houses. The demonstration building uses the cost-effective technology.

Figure 11: Demo House

4.4.2 Bungamati Project by SONA

SONA prepared three individual designs for Bungamati community which as the result of several meetings with community of Bungamati and hard work of Rebuilding Nepalese Homes, SONA's early intervention design initiative program Committee.The main objective of this project was the preservation of historical settlement by combining new building technology with traditional building forms.

Figure 12: Bungamati Project

4.4.3 Disaster Risk Reduction and Community Resilience by LUMANTI Support Group for Shelter

LUMANTI implemented project on "Community Managed Post Earthquake Reconstruction in Urban Poor Communities in Nepal". This project was meant for reconstruction and repair of earthquake affected houses with people participation in community level in partnership with local women cooperatives and community groups.This empowered residents to take

[5] Shelter and Local Technology Development Centre

initiation on mapping of their own households in terms of damage grades and land conditions.User committees were formed to make mutual decisions on beneficiary selection, prioritization, mason mobilization, material procurement, paper works for municipal approval for successful reconstruction of households and neighbourhoods.

Figure 13: LUMANTI Support Group for Shelter Reconstruction Phase

5. Data Collection and Findings

Semi-structured interviews were chosen as most appropriate for this research project. Architect each from DUDBC [6], SONA [7], and Lumanti, involved in post disaster reconstruction after the Gorkha earthquake were interviewed. Following are the key findings emerged from the interview:

- Lack of coherent policy for architect's role in rebuilding
- Lack of extensive research as 'one size fits all' approach is not suitable in context of Nepal
- Lack of inclusion of social recovery giving more focus on physical recovery
- Lack of strong group of architects

[6] Department of Urban Development and Building Construction

[7] Society of Nepalese Architects

5.1 Observations from Case Studies

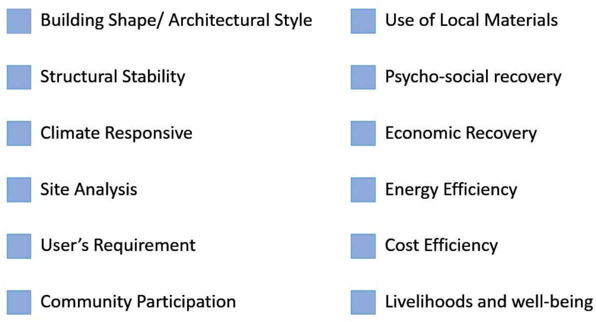

Figure 14: Indicators for resilient communities from case studies

- Must have the architectural essence of the community
- Use of stable and regular forms
- Proper use of different technologies with respect to the site condition and availability of material can be seen
- Climate plays a significant role in conditioning the design.
- Slope stability, fault rupture, liquefaction, ground topography, etc. need to be considered during site analysis
- User's requirements need to be catered as a first priority with respect to the user's social background, occupation,etc
- Participation of local people
- Use of local materials in construction
- Psycho-social recovery has not been considered as a part of reconstruction
- Relation of the design of housing with the economic recovery of the user
- The climate responsive design is ultimately energy efficient design

5.2 Findings from the process of reconstruction in Nepal

- A typical design does not showcase the architectural style of the locality

- Recommendations to follow the standard NBC [8] code for structural stability
- The wholesome design catalogue published are not climate responsive as Nepal has different climatic zones
- No proper site analysis is done. The typical building design does not fit in all the areas damaged during the earthquake
- The typical housing does not cater requirement of all the user group as they belong to different communities/ social background/ occupation
- Participation of local people cannot be observed in all cases of reconstruction
- Use of Local Material is not encouraged in the design
- Pyscho-social recovery has not been considered as a part of reconstruction
- No relation of the design to the economic recovery of the user
- Energy efficiency techniques are not mentioned in the design
- The design has proved to be failure as it does not support the user's Livelihoods and well-being to build back better

6. Conclusion

This research paper helps to gather the idea that "architects" and "architectural process" can contribute greatly to the resilience and sustainability of a community. It is expected of architects to realize people-oriented projects that are an amalgamation of architecture that responds to humanitarian beliefs as well as deals with the technical issues and the environment. The restoration and the reconstruction phases being the crucial stage of the DM cycle follows through the fact that if a disaster (small to magnanimous in proportion)should take place, then the community should be resilient or prepared enough to fight the situation successfully and spring back to normalcy in a short period of time without much ado. This paper hence, sheds light on those exemplary works by architects that have made a significant contribution towards the society and had helped people/ can help to get back to their feet after a disaster. Similarly, the show-casing of innovative works and interventions from all over the world can act as a platform of a new set of emerging architects, designers and planners having the capacity to "build" ,"re-build" and most importantly "build back better" (BBB) resilient "homes" to "sustainable nations". Hence, this paper realizes the fact that mainstreaming of a certain profession or practice is a draw-back and that it should be able to change and evolve with time and open a window for architects and designers in the world DRM [9] platform.

7. Recommendation

The reconstruction and preparedness phases in the disaster risk management cycle often overlook the "community" and the "designers" who bear the optimum skills and knowledge of re-building. This maybe because of the lack of awareness and understanding. However, the instillation of the concept of architectural innovations may solve the problem of un-coordinated and inappropriate housing solutions before and after a disaster. The idea of comprehensive, innovative design solutions need to be brought to attention of the GO's [10] ,NGO's [11] and people alike through projects that have been "realized" or "conceptualized" to be a successful example of sustainability and resilience.

The new interventions and solutions need to be introduced and accepted by the key professionals and administration in the disaster management system. This practice will not only highlight the profession of architects in a new light but also will improve the activities before and after the implementation process. The "build back better" principle can be achieved if solutions are provided by experts namely architects and planners who possess adequate knowledge about reconstruction and re-building and not just temporary restoration. This will result in development activities that will follow a process through trial and error and participation and the result shall be fruitful for the future thriving of communities from disasters.

[8] Nepal National Building Code

[9] Disaster Risk Management

[10] Government Organizations

[11] Non-Government Organizations

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