

2012

# Implications of Chakrata Road Widening Efforts

## A Report

*Road widening and enhanced building vulnerability*



**Disaster Mitigation and Management Centre**  
(An autonomous institution of the Department of Disaster Management,  
Government of Uttarakhand)  
Uttarakhand Secretariat , 4 Subhash road Dehradun 248001





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**4 Subhash Road, Dehradun – 248001**

**Uttarakhand, India**

**March, 2012**

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## Foreword

Ill planned and executed developmental initiatives often set the ground ready for major disasters in future. In a bid to solve the problems of one sector we thus end up adding to the miseries of other sectors. Road construction in the hills without due regard to geological instability of the slopes is clear example of this. It is therefore important to study the ramifications of the developmental process so as to learn lessons from the same and pave way for effective and better implementation of similar schemes in future.

Traffic congestion is a common problem of most urban areas and managing the same is becoming the biggest challenge for the civic authorities. With economic growth and development vehicular traffic in most urban areas is witnessing a fast growth and it is responsible for a number of problems that encompass the sphere of health, safety, environment, economy and global warming.

A number of diverse approaches have been adopted for solving this important problem. While the developing countries have focused on infrastructure development so as to accommodate the vehicles, most developed countries have resorted to discouraging use of private vehicles by providing rapid mass transportation options.

Dehradun, the capital city of Uttarakhand, is presently witnessing a major road widening exercise along Chakrata Road in the vicinity of Ghantaghar. This is perceived to solve the traffic related problems along this important road stretch. Similar exercises are sure to be taken up elsewhere in the state as also in Dehradun. It is therefore important to critically review this exercise so as to take up similar exercises in better planned fashion in future.

This report is the outcome of the efforts put in by the DMMC team that comprised of Dr. Girish Chandra Joshi, Ms Aneeta Salaria, Dr. K.N. Pande and Ms Bhavna Karki. All are congratulated for their sincere efforts at different stages of report preparation. Shri Mahesh Bhatt of Sarokar is thanked for support in the field. Cooperation of the residents of Chakrata Road is highly appreciated.

01 March, 2012  
DMMC, Uttarakhand Secretariat  
Dehradun

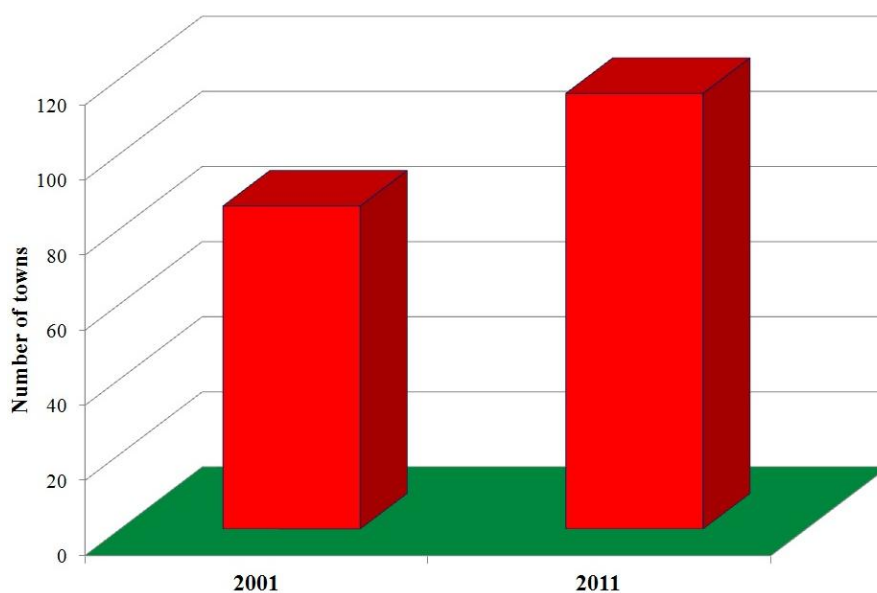


**(Piyoosh Rautela)**  
Executive Director, DMMC

## 1. Introduction

Nearly half of the world's population (47 per cent) lives in urban areas; a figure which is expected to grow at the rate of 2 per cent per year during 2000–15 (United Nations Population Division, 2001). Cities are the locations that have a high level of accumulation and concentration of economic activities and are termed as complex spatial structures that are supported by transport systems. Most transport and traffic related problems are often associated with urban areas. These creep up as the existing systems fail to satisfy the mobility requirements of the urban dwellers. Traffic congestion and lack of parking space are amongst the major problems of most urban areas. Increasing vehicular traffic density in urban areas is one of the main reasons of growing number of road accidents and related fatalities.

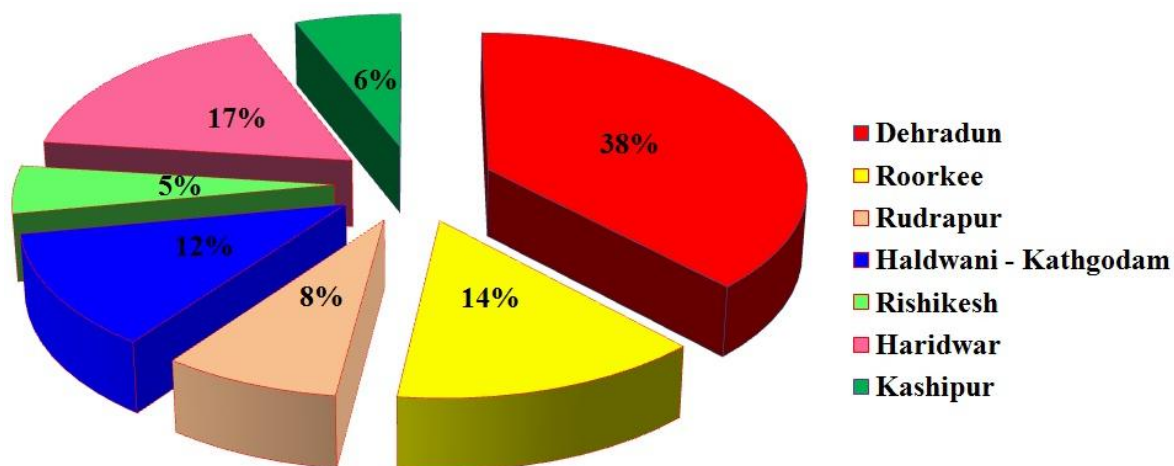
Lagging behind in growth and development population of Uttarakhand is traditionally considered to be largely rural in character. The urban population however accounts for 30.56 percent of the total that is comparable to the national average of 31.16 percent (Census of India, 2011). It can thus be said that the scenario for urban population in Uttarakhand is no different from other parts of the nation. In the previous 10 years (2001 – 2011) number of towns in Uttarakhand have registered a significant increase; up from 86 to 116 .Urbanisation is a phenomenon that is to increase with passage of time and so the problems of the urban areas are bound to become increasingly complicated and complex unless serious efforts are made to find innovative and lasting solutions.



**Fig. 1. Diagram showing increase in number of towns in Uttarakhand between 2001 and 2011.**

*Source: Census of India, 2011.*

As per Census statistics Uttarakhand has 7 urban agglomerations / cities with population of 1,00,000 and above (Census of India, 2011). Among these Dehradun urban agglomeration has the highest population (7,14,223) and accounts for 38 percent of the population of all the seven agglomerations.

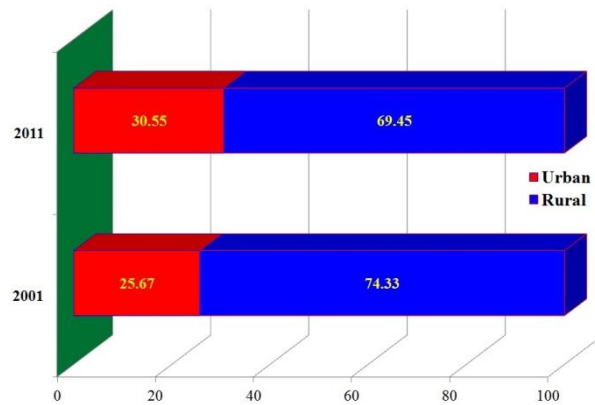


**Fig. 2. Percentage share of population within seven major urban agglomerations of Uttarakhand.**

*Source: Census of India, 2011.*

Between 2001 and 2011 urban population of Uttarakhand has increased by almost 5 percent at the cost of the rural population that is presently 69.45 percent (Census of India, 2011). Changes in the character of an urban centre often multiply economic functions and consequently it expands both horizontally and vertically. With the creation of Uttarakhand state Dehradun was elevated to the status of the state capital and this has resulted in sharp rise in the population. The urban population in Dehradun has thus risen to 55.9 percent in 2011 (Census of India, 2011). The decadal growth rate of urban population of Dehradun district is thus 39.90.

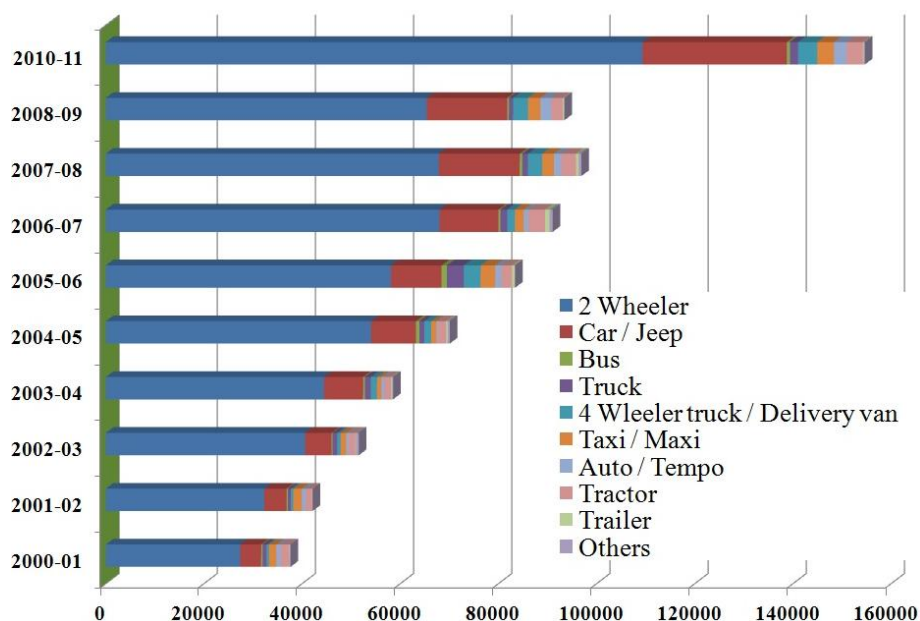
In the previous 11 years, since the creation of the state Dehradun has grown tremendously. In this period the population of Dehradun city has increased from 4,47,808 (Census of India, 2001) to 5,78,420 (Census of India, 2011) registering a decadal growth rate of 29.16 percent. In the same period the Municipal area of the city has increased by almost 20 percent (from 52.00 to 62.3 sq km).



**Fig. 3. Diagram showing increase in the proportion of urban population of Uttarakhand between 2001 and 2011.**

*Source: Census of India, 2011.*

Urbanisation generally results accumulation of wealth that is reflected in greater consumption of various consumer goods. Sharp increase in the urban population after the creation of the state has thus been accompanied by corresponding increase in the vehicular traffic density which can well be assessed from the very fact that in this period the number of vehicles being registered annually in the state has gone up by 311 percent. 37,650 vehicles were registered in 2000-01 as against 1,54,666 in 2010-11. In the year 1999-2000 there were 3,97,263 registered vehicles in Uttarakhand while in the year 2010-11 the number of registered vehicles have increased to 11,79,709; an increase of 196 percent.



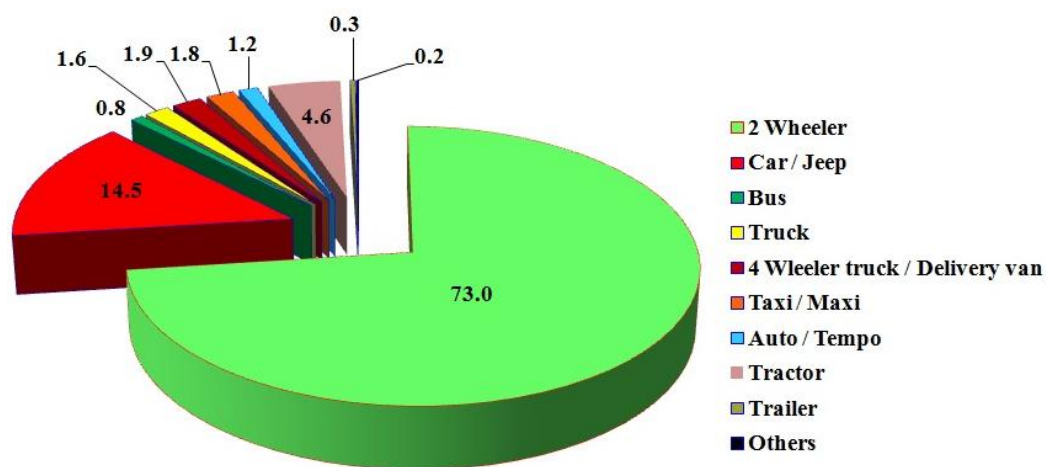
**Fig. 4. Mode wise breakup of the vehicles being registered annually in the state of Uttarakhand.**

*Source : Website of State Transport Department, Government of Uttarakhand  
(<http://transport.uk.gov.in>)*



As per the data the year 2010 -11 registered highest increase in the number of vehicles being registered. Two wheelers and private four wheel vehicles respectively account for 70 and 19 percent of the total vehicles registered in this period.

Moreover of the 11,76,709 on road vehicles in Uttarakhand (in 2010-11) 66 percent have been added after the creation of the state and in 1999-2000 the state had only 3,97,261 on road vehicles. Two wheelers and private four wheel vehicles constitute majority of the on road vehicles in Uttarakhand. Large proportion of these vehicles have been registered in Dehradun and thus added to the vehicular traffic load of Dehradun.



**Fig. 5. Proportion of different categories of on road vehicles in Uttarakhand in 2010-11.**

*Source : Website of State Transport Department, Government of Uttarakhand  
(<http://transport.uk.gov.in>)*

The traffic and transport sector in the state has thus witnessed an unmanaged growth and requires immediate attention, particularly in urban areas. Prolonged neglect of this important sector has made most cities of the state prone to traffic delays and jams. In most developed countries urban traffic and transport related issues are addressed by, i) promoting rapid mass transport facilities, ii) discouraging use of private transport by enhancing parking and entry cess, iii) discouraging purchase of private vehicles by increasing registration fee of vehicles, iv) discouraging the use of both diesel and luxury vehicles by imposing additional cess on the purchase and use of these and v) improving the transport infrastructure network by way of developing new roads, flyovers, subways and pedestrian passageways.

Unfortunately none of these issues have been given a serious thought by the traffic managers of Uttarakhand. Parking in most places costs nominal and one is free to park at any place unmindful of the inconvenience caused to other commuters. Low interest rates on vehicular loan further together with the provision of transport allowance for the employees promote use



of private vehicles. Together with this the public transport is still erratic, slow, inconvenient and uncomfortable.

Increase in traffic density coupled with lack of serious efforts to manage the same have resulted in traffic congestion in Dehradun city as the transport demand far exceeds the transport supply in the city. Incidences of marginal delays are thus increasing and driving speeds have become problematic. Proper road hierarchy is not followed in the city and especially narrow city roads in the old city area result in traffic jams.

The vehicular growth in the city is increasing and there exist a deficit in terms of both parking and driving space. The efforts aimed at solving the traffic related problems of the city in the first stage focused on regulating traffic by allowing one way traffic through identified roads and disallowing entry to city buses in certain areas. These however failed to yield desired results and therefore attention was focused on widening of the existing roads. This is perceived to solve the emerging issues of peak hour traffic jams and congestion.

Chakrata Road near Ghantaghar, in the heart of the city, represents one such stretch taken up for road widening. Important issues related to road widening i.e. land acquisition, rehabilitation of the affected persons and redevelopment of the affected area, were however not taken up in an integrated and planned manner. Unmindful of the larger good of the city, every party has been engaged in bargaining a better deal for himself out of the road widening exercise and in the process a number of serious issues have been missed out.

It seems that the enthusiasm of the authorities to get rid of the traffic related problems of Chakrata Road is going to create other related problems that might have long lasting and serious repercussions. The structural safety of the partially demolished buildings is an emergent issue at this point of time. This report is thus an attempt to look into the various issues related to the widening of Chakrata Road and to suggest measures that might be worth consideration while undertaking similar exercise in other areas.

## **2. Background**

Mussoorie Dehradun Development Authority (MDDA) has the mandate of ensuring better, planned and organised growth and development of Dehradun city and thus it is entrusted with the responsibility of widening the Chakrata Road.

It is important to highlight here that the Chakrata Road enjoys the status of National Highway and the existing width / effective carriage way of the same was restricted to approximately 10

meters that was insufficient to sustain the traffic load of the city. The widening of Chakrata Road was thus under consideration for the previous many years.

Due to the narrow passage and ever increasing traffic load traffic jams had become a routine affair for Chakrata Road, especially during the peak hours. Alternate non-structural traffic management strategies tried out in the previous years had proved ineffective since the width of the road was not sufficient to sustain even minimal vehicular traffic load.

Road widening, especially in thickly populated and commercialised urban areas is a highly sensitive and complex issue as it has to satisfactorily address the interests of the affected community. These issues are required to be dealt both at community and the concerned authority level.

MDDA is presently undertaking widening of Chakrata Road and in the process existing structures on the acquisitioned land on both sides of the road are being demolished. Planned demolition and reconstruction is a part of city development but partial demolition and unplanned reconstruction is certainly going to invite a number of new problems.

There is no doubting the fact that widening of Chakrata Road would ease out traffic flow across the heart of the capital city. Earlier the width of Chakrata Road was 5 meters near Ghantaghar which increased to 12 meters while moving towards Connaught Place but the same was encroached upon by parked vehicles. Now the same road is being widened to 24 meters and would thus be accommodating more vehicles on this stretch. It is however important here to take into account the carrying capacity of the other roads and short distance between the roundabouts. It is thus worth considering if this measure would not lead to increased traffic jams at other important locations and unless the other roads are not appropriately widened piecemeal prescriptions are only going to result in multiplicity of duplicated expenditures with no lasting respite to the commuters.

Chakrata Road is one of the important routes that carries the load of intra as well as inter city traffic of Dehradun. The demolition work on Chakrata Road was taken up in three phases starting from December 2011. The whole exercise was carried out jointly by District Administration, Public Works Department (PWD) and MDDA. The structures to be demolished having been identified in advance, notices were served to the property owners and residents of the area well in advance. In order to ensure safety of the passersby whole zone was declared as a no traffic zone and with involvement of key departments the process of demolition was carried out. It involved a series of discussion of MDDA with the concerned stakeholders of the area.

### **3. Objective**

The objective of this report is to focus on various issues associated with the widening of Chakrata Road. Road widening is the need of hour but it is much more than just bulldozing the existing structures. This exercise should ensure minimal structural damage in the undemolished structures and at the same time reduce future risk. The objective here is to understand what exactly the demolition process resulted into, and to throw some light on the presently prevalent construction practices which might prove out to be dangerous in future.

The report briefly describe the present scenario so as to formulate a long term strategy for demolition of structures as also to suggest ways of making the present exercise more effective. The present study is mainly focuses upon partially demolished structures that if not treated properly might pose a threat to public safety.

### **4. Methodology**

This report is largely based upon the observations made in the field during different phases of the demolition exercise together with the interactions with the affected community members. The details of the data to be collected in the field was first finalised and the same was collected through primary survey. This data included structural damage incurred to the partially demolished structures and assessment of their vulnerability.

For the purpose of analysis the buildings all along the stretch have been classified into three groups and discussed on the basis of construction pattern, effect of demolition and construction practices prevalent presently.

Based on the above attempt has been made to put forth suggestions for improving the vulnerability scenario of the area.

### **5. Visual Inspection**

This road widening exercise has a direct impact on socio-economic life and life support strategy of the population residing along the affected stretch of the Chakrata Road. Since the roads are central to various socio-economic interactions in a particular area, the widening exercise if not undertaken with due care might disrupt the local interactions.

In order to understand the demolition process and to have a feel of the work in progress repeated inspections of the site were carried out. This process involves taking note of any visibly evident defect in the structures together with their overall condition. During the course of fieldwork visible defects in both the building exterior and in situ portions of the partially

demolished buildings were taken note of and wherever possible photographic evidences of the same were collected.

The demolition work was observed to affect a stretch of around 300 metres on both the sides of the Chakrata Road starting from Ghantaghar. Most buildings covered by demolition were observed to be residential cum commercial in nature; ground floor being utilised for commercial use while the upper floors being residential.

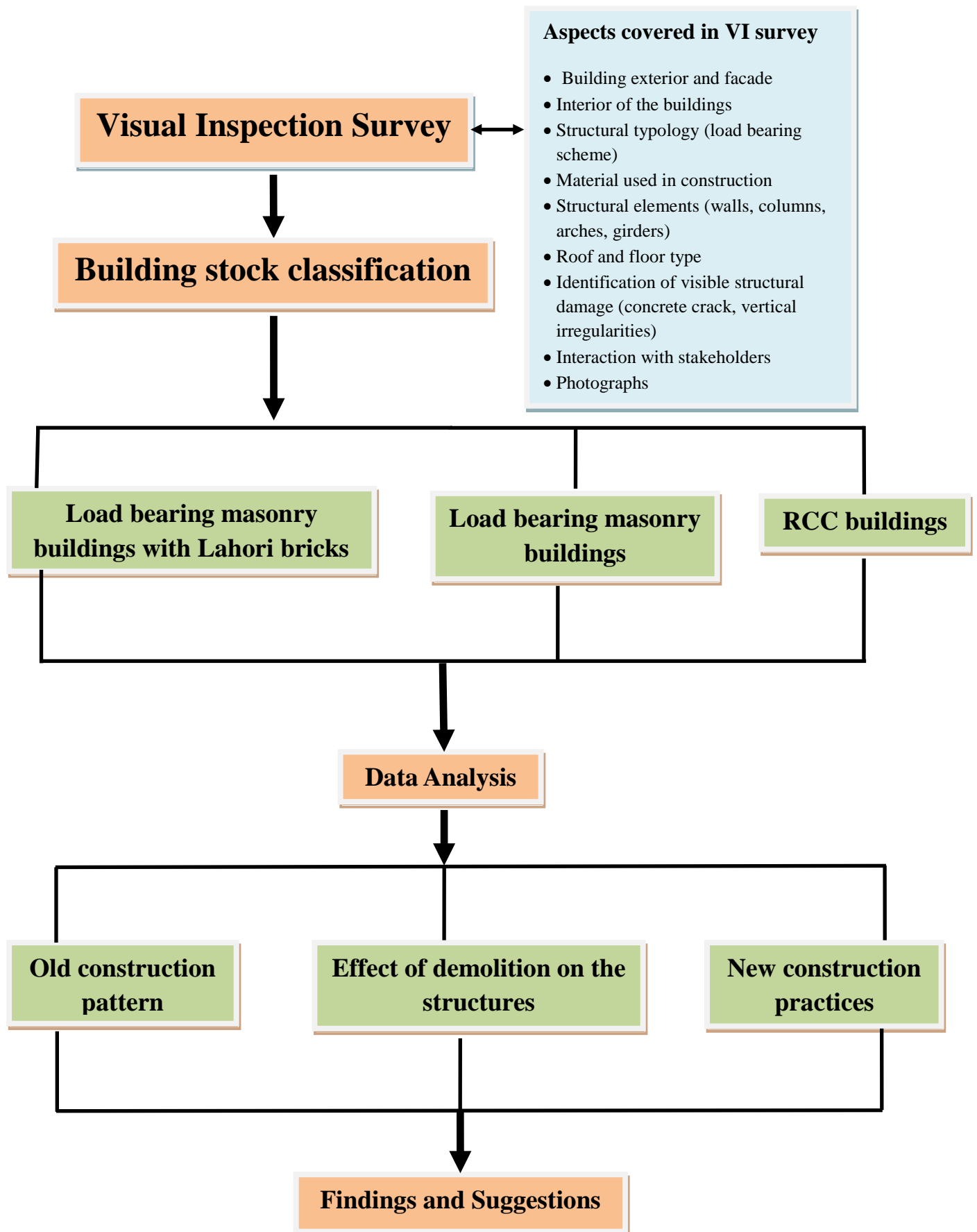
The built up area falling within the 24 metre marking from the centre line of the road was observed to have been affected by demolition leaving behind many partially demolished structures. The people were observed to occupy and reside in many of these partially demolished buildings. In some plots the owners were observed to be engaged in restoration of their structures and this included erection of structures (pillars and exterior walls) to support the existing roof.

The field visit brought forth an important point that the demolition has not been carried out in a planned and systematic manner. Bulldozing of the structures was observed to have rendered the partially demolished buildings more vulnerable as the methodology employed for demolition resulted in the development of major cracks and other weaknesses in many of the buildings. This is sure to add to the vulnerability of the area.

The pace of reconstruction was observed to be sluggish as the issues relating to setback and rehabilitation were still not settled. The state of many partially demolished buildings was observed to be highly vulnerable and their collapse could pose a serious threat to public safety.

Based upon the field work the building stock affected by demolition has been split into three categories that include i) load bearing masonry buildings with Nanakshahi / Lahori bricks, ii) load bearing masonry buildings, and iii) RCC buildings. So as to have a better grasp of the situation all the three categories have been analysed on the basis of i) old construction pattern, ii) effect of demolition on the structures, and iii) new construction practices at the site.

This analysis has helped in better understanding of various issues related to building vulnerability in all types of buildings present in the area. The study thus reflects the effect of road widening on the whole stretch and not to a single building type. All the three building categories have been separately described and analysed in the sections below.



## 5.1 Load bearing masonry buildings with Nanakshahi / Lahori bricks

**5.1.1 Old construction:** The majority of the structures on the southern side of the Chakrata Road are observed to be load bearing masonry structures. There is not even a single framed structure on this stretch. This area constitutes old part of Dehradun city and a number of buildings in this portion are observed to be built with Lahori bricks. These bricks were largely used during the Mughal period and were put to disuse during the British rule. Use of these bricks is thus indicative of antiquity of these buildings and this construction can safely be said to be at least 100 years old.



*Fig. 6. The old structures on the southern side of the Chakrata Road made mostly of Lahori bricks.*



*Fig. 7. Partial demolition of the houses.*

Moving along the road most structures on the southern side were observed to be old. The ground floor of these structures was observed to be particularly old and estimated to have been constructed 50 – 100 years before present. The upper storey was however observed to have been added later. Vertical discordance due to use of different building materials and construction techniques makes these structures particularly vulnerable.

Stones and bricks with lime mortar were observed to have been used in the construction of the walls of these structures. The masonry construction was observed to exhibit signs of brittle failure.

This type of construction is relatively economical and was observed to dominate the building stock of the area. Walls of these structures were observed to be particularly thick ranging between 300 to 450 mm and made using Lahori bricks with inner and outer wythes.

Generally the buildings were observed to be not well separated from each other and the maintenance of these has not been accorded due importance. This might be attributed to disputes relating to ownership, multiple ownership and tenancy.

The roofs of most structures in this area were observed to have been supported by wooden joists, and mud mortar mix. As a result of partial demolition the load mass concentration of the damaged roof was observed to have shifted towards the remaining walls. Reconstruction of such building without appropriate technical inputs and advice would adversely affect the overall stability of the building.

Another specific architecture feature observed in this particular stretch was the uses of arches. An arch is a structure that spans a space and supports a load. Arches appeared as early as the 2<sup>nd</sup> millennium BC in Mesopotamian brick architecture and their systematic use started with the Ancient Romans who were the first to apply this technique to a wide range of structures. The arch is significant because, in theory at least, it provides a structure which eliminates tensile stresses in spanning a great amount of open space. All the forces are resolved into compressive stresses. This is useful because several of the available building materials such as stone, cast iron and concrete can strongly resist compression but are very weak when tension, shear or torsional stress is applied to them. By using the arch configuration, significant spans can be achieved as the compressive forces hold the material together in a state of equilibrium. This even applies to frictionless surfaces. However, one drawback of this technique is that an arch pushes outward at the base, and this needs to be restrained in some manner, either with heavy sides and friction or angled cuts into bedrock or other similar technique. Arches have thus been one of the architectural elements used for aesthetic and visual appeal in addition to functional importance.

The walls in the constructions under present focus at Chakrata Road were observed to have segmental arch openings. Being termed segmental arches their main function was to provide support at openings in the masonry construction. Besides being simple to construct the segmental arches are considered to be the most stable. These arches can support a large load as the downward acting forces are transferred through the arches to the foundation; spreading out the load. The use of arches clearly indicates the antiquity of the buildings.

The arches were observed to have been used for creating openings; mainly for doors and windows. The arches used in the construction on this stretch of Chakrata road were thus observed to support uniformly distributed load of the roof slabs made up of bricks and lime surkhi mortar. Under uniform loading the individual masonry units of the arches remain in



compression and not in tension. The iron girders provided in these structures act as simple support beams to carry uniformly distributed load.

Partial demolition of the iron girders has led to uneven concentration of load that can lead to development of shear cracks in the structures. It is a must therefore that appropriate technical support be taken while restoring the partially demolished buildings so as to avoid uneven load distribution.

**5.1.2 Effects of the partial demolition on construction:** While demolition is still not complete and the dispute on various matters remains to be settled, people at some places were observed busy trying to restore their partially demolished structures; that too in a hurry and without appropriate technical support. It is important here to note that this is resulting in amalgamation of the old construction with the new and if undertaken without appropriate structural safety related aspects can result in enhanced vulnerability of the structures.



*Fig. 8. The cracks developed on inner walls of the building.*



*Fig. 9. Highly vulnerable structures with multiple weaknesses must be fully demolished to avoid the risk.*

It needs to be appreciated that before undertaking any demolition exercise it is a must to analyse its impact on the partially demolished / undemolished structures and at the same time while undertaking restoration of the partially demolished structures it is a must to take note of the various effects of demolition on the structures. In the present exercise this important aspect seems to have been ignored. It seems that the structures were bulldozed without

considering its impact upon the remaining built up area. This is sure to add to the structural vulnerability of the entire area.

The partially demolished structures in this area were observed to have developed cracks on internal walls as also on the roofs and these are attributed to the technique used for demolition that mainly consisted of persistent hammering. These cracks would ultimately render these buildings unstable and ultimate sudden collapse of some of these cannot be ruled out during extreme natural events related to seismic shaking and precipitation.

The arches used in the construction along this stretch of the Chakrata Road were observed to have been damaged badly. In a number of cases iron girders supporting the arches were observed to have been displaced from their original position and any attempt to restore these structures without appropriate technical support is bound to invite a major devastation in future.



*Fig. 10. The damaged segmental arches of the buildings at chakrata road.*

The arches were observed to have been used in a group of two or three segments joined together with the help of girders inserted in between these segments to provide support to load of the roof placed above it. The demolition of this important feature of the structures was observed to have resulted in the development of tension cracks within the remaining portions of the arches that would adversely affect the structural strength of the building.

It can therefore be safely concluded that the partially demolished structures in this stretch of the Chakrata Road have been rendered highly vulnerable and as the girders provided for

support have either been removed or partially damaged, the roof might easily collapse even under a small triggering force.

**5.1.3 New construction practices:** On the southern side of Chakrata Road the restoration work was observed to be going on at a relatively slow pace. It was only at one or two places that restoration related efforts were noticed. These efforts are attributed to commercial pressures. In the field it was observed that the property owners were busy erecting walls to support the roofs of the partially demolished structures. The problems associated with vertical irregularities present in the building were not observed to have been addressed in all the cases. It seems that the property owners have not resorted to technical advice of any sort.

The reinforced brick roofs of the partially demolished structures on this stretch of the Chakrata Road were observed to have been temporarily supported by wooden planks while building surgery was on. Attempts were mainly observed to have concentrated on ensuring restoration of the maximum covered area possible. It was observed that proper attention was not being paid to ensure proper bonds and the continuity; both at corners and wall junctions. In case of the arches no restoration effort was observed and people seemed unaware of the methodology to be deployed for restoration of the damaged arches or to repair the roof that was previously supported by iron girders.



*Fig. 11. The vertical columns being erected to support the hanging roof.*



*Fig. 12. New construction practice observed at the site.*

Most reconstruction work was observed to be carried out in haste so as to resume commercial activity as soon as possible. These works were observed to be carried out by the property

owners without technical input of any sort on the type of building material to be used or technique to be employed for restoration.



*Fig. 13. The new shops being constructed on the ground floor of the partially demolished structure while the upper floors still remain in dilapidated condition.*

To sum up it can safely be deduced that the vulnerability of the structures that were inherently weak and vulnerable is sure to be enhanced by the demolition exercise and this area is sure to prove out to be a sore point of the capital city in times to come.

## **5.2 Load bearing masonry buildings**

**5.2.1 Old construction:** Load bearing non-engineered masonry structures (built using normal bricks) were observed to dominate the built up area on the northern side of the Chakrata Road. Majority of the buildings in this area were observed to be two storeyed, not well spaced and often attached to each other. These buildings thus do not inherently follow mass space relationship.

Majority of the buildings in this area were observed to have RB roofs while only a few (2 or 3) structures had RC roofs. Some 2 or 3 storey buildings were however observed to have RB floors and roofs of GI sheets. As in the previous stretch a few buildings (2 or 3) on this stretch were also observed to have specific architectural features related to arches. Girders were also observed to have been placed in between the segments to support the load of the roof in these structures.





*Figs. 14 and 15. The load bearing masonry construction with RB roofs to the north of the Chakrata Road.*

**5.2.2 Effects of the partial demolition on Construction:** Since the demolition was not carried out systematically partially demolished structures have been rendered more vulnerable. It is worth noting that cracks are the first signs of deterioration of any building and these have a direct bearing upon the serviceability and stability of the building. At many places the cracks have been identified in the buildings.



*Fig. 16. The cracks developed in the partially demolished building enhancing its structural vulnerability.*

The arches were observed to have been damaged severely and the iron girders inserted in between two segmental arches for strength and support were observed to have been partially damaged or removed. This is sure to affect the load bearing capacity of the same and enhance structural vulnerability of these structures.



*Fig. 17. The damaged arches and the load of arches being supported by being planks.*

**5.2.3 New construction practices:** The restoration work was observed to be taking place in a haphazard and inappropriate manner; proper care was not being taken to erect the supporting walls and pillars on appropriately deep and firm foundation. At the same time proper connections were not being provided between different building elements. It was also observed that in some buildings no hierarchy was being followed while constructing new columns. Such construction faults can easily be observed in the area and these are bound to result in enhanced vulnerability of the building stock in this area.



*Figs. 18 and 19. The new construction practice at the site; irregular / tilted columns being constructed.*

Drainage work was also observed to be in progress on this stretch of the Chakrata Road. While the work is still not completed and the shop owners were observed to run their commercial establishments even without proper and safe access. Though a temporary

arrangement, wooden planks being used to bridge the gap created by the drainage works are poorly placed and can cause mishaps.



***Figs. 20 and 21. Drainage work in progress along with the poorly placed wooded planks to ensure customer access.***

Despite confusion of different sorts at various levels, the construction work was observed to be going on. The quality of construction work is a major concern as building safety related aspects were observed to be blatantly ignored. Besides the safety haphazard construction is aesthetically unappealing. Overall vulnerability of the structures on this stretch of Chakrata Road is thus sure to increase.



***Fig. 22. poor construction quality of the new structures.***



***Fig. 23. Ground floor construction with weak upper storeys can lead to a disastrous situation.***



## 5.3 RCC Buildings

**5.3.1 Old construction:** The stretch of the Chakrata Road presently taken up for widening was observed to have only a few RCC structures that include RGM Plaza that was observed to be a well framed structure with raft foundation.



*Fig. 24. View of RGM plaza on the Chakrata Road.*

**5.3.2 Effects of the partial demolition on Construction:** It was observed that the demolition has resulted in a number of cracks in the undemolished portion of the building. Moreover removal of the columns in the front side of the building is sure to adversely affect its stability and performance



*Figs. 25 and 26. Cracks developed along beam and arches because of lack of systematic approach followed in demolition.*

**5.3.3 New construction practice at site:** The foundation related aspects were observed to be ignored while undertaking restoration. The new columns in G+3 RCC buildings were not observed to follow the principles of regularity / hierarchy.



*Figs. 27 and 28. New construction practice at site.*

The new construction on this stretch would have to accommodate high density because of the residential cum commercial character of the area as also its proximity to the National Highway. The loss structural strength of the buildings cannot be regained by the techniques observed to be employed for restoration. In view of seismic hazard in the area if the risk is intended to be minimised detailed investigations have to be undertaken in consultation with a team of experts before attempting restoration in the area.

## 6. Conclusion

No denying the fact that widening of Chakrata Road would help in easing out the traffic congestion and improve traffic flow. Traffic jam related problems on this important road stretch would thus be solved, at least for some time.

But we must not deviate from the basic principle of sustainable development that emphasises that remedy for one sector should not result in the woes of other sectors. This principle has clearly been ignored in this case and the widening of the road has resulted in enhanced vulnerability of the building stock in this area.



*Fig. 29. No proper hierarchy of columns being followed in construction which will lead to structural instability.*

The demolition and reconstruction, particularly in the urban areas in a normal exercise but this is governed by either of the two underlying principles; i) conservation of the traditional architectural or aesthetic aspects, and ii) redeveloping the area in unison with modern developmental principles keeping in view the emerging needs. Unfortunately both these aspects have not been taken note of while undertaking widening of the Chakrata Road. Besides adding to the vulnerability of the structures, this is sure to set a bad precedence of

bargaining and relaxation of rules and norms that would adversely affect future redevelopment projects.

On the basis of the observations made in the field and the analysis of the data collected, both before and after the demolition, it is concluded that widening of the Chakrata Road has enhanced structural vulnerability of the building stock on its both sides. The patching up of cracks, repair and replacement of roof elements in the partially demolished structures is surely not going to restore the lost structural strength of the buildings. Lack of proper connections between different building elements and ignorance of the importance of deep and firm foundation while resorting to the restoration of the structures is further going to enhance structural vulnerability of the building stock.

Organised and planned redevelopment of the entire area would have been the best solution but even if the option of redevelopment was not being exercised MDDA would have facilitated organised technical support for restoration of the partially demolished buildings as individual property owners are not likely to seek technical support. Having provided the technical support and guidelines for restoration of the partially demolished structures MDDA would have been in a position to dictate terms to ensure restoration work accordingly. This not being the case here, the individual property owners are free to restore their property in a manner that they deem fit. In the process the issue of safety of the masses is being compromised.

In such cases where the option of partial demolition is being exercised the choice of restoration cannot be left to the property owners. It has to be prescribed and mandatory. Leaving the choice of the nature of restoration to the masses is invariably going to enhance the vulnerability of the building stock which is not in larger good of the public.

It should be understood that partial demolition is not a wise option for city development and it should therefore be used sparingly. Every attempt should therefore be made to bring forth consensus amongst various stake holders to go in for complete demolition and organised reconstruction on the available space. Besides reducing the structural vulnerability this would at the same time result in win - win situation for all the parties involved. This would provide a modern look to the city besides providing more of covered area that could be utilised for various purposes. This would also cut short the expenses on rehabilitation of the property owners as the extra covered area would be enough to meet the cost of redevelopment. This exercise would however not be easy and would require much more effort from all the key players. But the effort is worth making as it would result in long term solution of a number of problems at one go.

Before demolition of buildings detailed investigation of the existing building stock should be undertaken and appropriate demolition strategy should be planned. In all partial demolition works every effort should be made to ensure that the undemolished portion of the building does not sustain major structural instability. At the same time codes are required to be developed for both partial and complete demolition of structures. Appropriate technology and implements have also to be acquired by the agencies responsible for undertaking demolition. It is an important issue as the experience of Sikkim Earthquake of 2011 suggests that the civic authorities lacked the necessary know how of safely demolishing the buildings rendered unsafe by earthquake.

The work place relationships must also be taken into consideration while rehabilitating the affected community. This aspect has not been taken note of in widening of Chakrata Road where the people have been allotted houses near ISBT, Dehradun while they have been allocated shops in the commercial complex near Ghantaghar. This move has thus increased the work place distance by manifold.

The restoration and reconstruction works have already commenced and soon the entire space would be choked with haphazardly constructed vulnerable buildings. It is doubtful if this building stock would be able to withstand extreme weather events and even minor earthquake tremors.

Each project is generally conceived and designed to achieve sector specific objectives with both economic and social benefits to the society. But no project can really afford to jeopardise the welfare and safety of a large section of the society and when the threat is largely obvious. The issue of haphazard construction has thus to be settled once and for ever and it is to be understood that time is at premium; so sooner the better. Once the people have already restored their property it would be difficult to convince them again for yet another demolition.

This complex situation could have been avoided if little more quality time and effort would have been devoted on this important issue during the planning stage. This issue at the same time cannot be ignored, not at least by the agency that has the mandate of planned and safe development of Dehradun city. So the masses have to be educated on different aspects of this important issue and efforts have to be made for evolving a consensus solution that reduces the vulnerability.

Traffic congestion is a common problem in most urban areas and road widening is often considered the most convenient and economical option for solving this problem. It is however a reality that despite massive investments on transport infrastructure all major cities continue

to face the problem of traffic congestion and road accidents. Initiatives related to road improvement that reduce travel time and cost are observed to attract traffic from other routes and ultimately increase traffic density of the improved road. The generated traffic that refers to the additional vehicular traffic on a particular road is thus always going to pose a serious threat to the viability of all road widening initiatives. Is it not likely that the ones presently preferring to travel towards Premnagar via Ghari Cantonment or to Clement Town via Saharanpur Chowk would be encouraged to travel through the widened Chakrata Road. Studies across the globe also indicate that road improvements that reduce congestion encourage more vehicular use. So the ones presently preferring to commute on two wheelers would be encouraged to use four wheeled vehicles. This might boost the vehicular market but would deteriorate air pollution scenario in Dehradun. There exists no doubt that the increase in the capacity of roads would provide certain specific benefits but the generated traffic would surely affect the nature and sustainability of these benefits.

It is also worth considering if the widening of a certain stretch of Chakrata Road alone can solve all traffic related problems of Dehradun. With other roads being not so wide, with frequent cuts on road dividers and short distances between roundabouts the road widening might very well lead to increased traffic jams at other important locations in the city and unless the other roads are not appropriately widened piecemeal prescriptions are only going to result in multiplicity of duplicated expenditures with no lasting respite to the commuters.

Road widening alone cannot solve the traffic related problems and experience around the globe suggests that a lasting solution of this problem lies in an integrated approach that is a happy blend of developing an efficient, convenient and improved public transport system and curbing use of personal vehicles.

There exist some important parameters that decide mass acceptability and use of any public transport system and these are required to be considered while planning the same for Dehradun. These include i) frequency, ii) comfort, iii) punctuality, and iv) economy. These parameters can be taken care of by, i) increasing the number of buses, ii) allowing only quality buses that cater to the comfort level of the commuters, iii) providing for separate lanes for the buses, iv) creating convenient, pleasing and comfortable pick up and drop points, v) promoting recreation and other allied facilities at pick up and drop points and iv) promotion of autos and taxis.

This has to be accompanied by conscious efforts to discourage use of private vehicles. This could be in the form of i) imposing exorbitant penalties on parking of vehicles in unauthorised places, ii) imposing exorbitant penalties on use of vehicles without valid driving

licence and other papers, iii) imposing exorbitant penalties on violation of traffic rules, iv) enhancing parking cess particularly in core areas of the city, v) imposing special entry cess in core areas of the city and connecting it to the duration of stay of the vehicle in that area, vi) imposing additional cess on the entry of vehicles bearing registration numbers of other states, vii) discouraging purchase of private vehicles by increasing registration fee of vehicles, and viii) discouraging the use of both diesel and luxury vehicles by imposing additional cess on the purchase and use of these.

The option of plugging the breaches in the road dividers should also be considered here for improving the road traffic related scenario in Dehradun.

Improved mass transport network together with discouraging use of private vehicles would at the same time reduce the road accident and air pollution related problems in the city. Moreover conscious efforts for catering to the safety and convenience of the pedestrians and cyclists would further reduce the traffic congestion. Some of these measures include i) provision of separate lanes for cyclists, ii) creating space for pedestrian walkways, iii) providing for pedestrian flyovers and subways. Moreover these measures are easy to implement, financially not taxing and technologically not demanding. These would however go a long way in improving the traffic related scenario in the city.

Global experience suggests that these efforts have significantly reduced the usage of personal vehicles and relieved the pressure upon the transport network. If implemented sincerely and in a well planned manner there exists no doubt on the success of these initiatives for improving the traffic related scenario in Dehradun. It is therefore urgently necessary that various good practices being followed in other cities across the world for managing their various traffic related issues be studied and debated so as to formulate an effective strategy for addressing this important issue in Uttarakhand.