

structures must be checked daily.

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2.2 SNOW REMOVAL

Introduction

In areas where winter weather affects the operation of a parking structure, removal of snow and ice is necessary, if not paramount, for functional performance, the public's safety, and the long-term durability of the structure. Snow and ice removal can be difficult depending on the size, timing, and type of storm, and also the area to be maintained. For these reasons, knowing with what and how to remove snow and ice can greatly affect the operation of the structure. The basic parameters for snow and ice removal include planning, proper equipment, chemical deicers, written procedures, and how-to instruction for snow removal personnel.

A. Planning

When removing snow and ice, planning plays an important role for a successful operation. Basic planning and specifications for snow removal begins during the initial design phase of the parking structure. The owner, architect, engineer, contractor, and precast/prestress concrete manufacturer must all be involved in determining how snow and ice will be removed. Operations such as removal of snow and ice from the deck surface, storage of snow and ice, and the use of certain types of equipment can cause major functional and performance problems to the structure if not properly addressed during the initial design phase.

When an architect begins considering the location and layout of a parking structure, snow and ice removal operations should be based on local climate conditions. Anticipated maximum snow fall and frequency will influence planning strategies. Once parameters for snow and ice removal have been established, features for storage or removal must be designed into the structure.

Removal of snow is typically handled by moving the snow to a snow chute or snow melting equipment, or by moving to and through a gate opening in exterior spandrels.

Storage of snow requires strict operating procedures and protected dumping zones to ensure the safety of workers, pedestrians, and vehicles. Multi-level parking structures also require special procedures to prevent the penetration of falling snow onto lower structure levels. The number of dumping locations depends on the parking structure size, anticipated snow fall rate, and adjacent property locations.

When snow is stored on the top level of a parking structure, it is essential that equipment operators be provided with detailed storage guidelines before each clearing operation. If guidelines are not provided in the original design, a structural engineer must generate guidelines for maximum storage-pile size, location, and height. Consideration should also be given to obstruction of sight lines, loss of parking spaces, and the deleterious effects of concentrated salts and deicers.

Snow melting equipment comes in various forms. Before a piece of equipment is chosen, the structure needs to be checked to ensure that structural components can safely support the equipment's maximum

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working weight. Typically, if wheel loads are larger than 3000 lbs or the total distributed equipment weight exceeds 50 lbs per sq ft, a structural engineer must verify the structural adequacy of the building components. Sufficient floor drainage is required to properly dispose of melted snow without the formation of ice patches on the deck surface.

Once a plan is developed, discussions with the owner/operator of the parking structure regarding responsibility for snow and ice removal is recommended. Contracted services and/or in-house maintenance are the common options for accomplishing the removal. The developed procedures should be conveyed to the proper personnel so there is no confusion regarding removal procedures.

One-level parking structures may provide accessibility for snow equipment that is heavier than the support systems allow. It is very important that rigid enforcement restricting heavy equipment be maintained.

Once the structure is in use, planning should also occur prior to the snow and ice season. Having personnel, equipment, and deicing materials available must be setup before the season begins. A written procedure is necessary for successful snow and ice removal planning. Included in the written plan should be a checklist of pre-season preparations. The snow removal guidelines and maintenance log should be easily accessible. Records of previous years' operations can facilitate answering future questions that may arise.

Obstacles to snow and ice removal such as the structure's expansion joints, joint sealants, membranes, signage, lighting, and floor drains should be identified and emphasized to operations personnel. They must be made aware of potential damage that may be caused when removing snow and ice. Markers highlighting obstacles may be setup prior to the beginning of the winter season and then removed when the season is over.

Adequate drainage is a critical component of proper snow and ice removal. Prior to the arrival of freezing weather, water-ponding areas on the deck must be eliminated. Drains should be cleaned of debris. Water lines used for surface cleaning should be drained of all water to prevent freezing and breakage.

B. Equipment

Removing snow and ice is typically accomplished by using equipment especially designed for the operation. Determining the type of equipment to use affects operation and the longevity of the structure. For example, a pick-up truck with a plow may not be the right equipment to use for all jobs.

Snow removal equipment comes in many sizes, weights, and systems. The selection of this equipment along with its accessories will determine the efficiency of the snow and ice removal operation. The weight of the vehicle and type of attachments also impacts the amount, if any, of potential damage the structure may incur. Typically, parking structures are designed for 3000 lb wheel loads. Higher loads must be approved by a structural engineer. Plows and other snow removal implements that come in contact with the driving surface should have well-maintained rubber blades to minimize damage to the deck surface.

The right type of equipment for placing chemical deicers is also important. This equipment must be able to spread deicers properly, efficiently, and cost effectively.

C. Chemical deicers

The use of chemical deicers can affect the structure's efficiency, life safety, and longevity. Deicers must be chosen prudently because of their chemical potency, availability, and cost. Improper use of deicers may be deleterious to surfaces to which they are applied.

When using deicers, it is necessary to wash-down deck surfaces immediately following the winter season. The use of a high water volume from a 1¼ in. or larger hose is recommended. During the initial design phase, consideration for sufficient water to clean all surfaces (i.e., floor levels in addition to the roof level) contacted by deicers is important. It should be remembered that chemical deicers are also deposited by vehicles parking in the parking structure, so cleaning of all levels is important even if deicers were not directly applied to lower floor levels.

There are many types of chemicals deicers. Some, like chlorides, are relatively inexpensive but are much more harmful to the structure than ureas or calcium magnesium acetate. It is recommended that sodium or calcium chloride (rock salt) deicers not be used. Deicing chemicals should not be used until the parking structure is at least one year old.

Stairs, landings, and other areas of pedestrian egress must also be clear of snow and ice. Other chemicals with less corrosive potential to the concrete such as calcium magnesium acetate (CMA) are recommended.

Deicers can adversely affect the environment. State highway departments are now minimizing the use of sodium or calcium chloride because of the detrimental environmental effects.

D. Snow Removal Procedures

The following guidelines should be followed during the snow removal process.

1. Snow plow blades should not come in direct contact with expansion joints, deck membranes, or joint sealants. Blades should be kept a minimum of ½ in. above these sensitive materials. Blades should also not impact vertical offsets between adjacent deck surfaces. Plows must be equipped with well-maintained rubber blades to minimize impact damage.
2. Reduced equipment driving speed should be used at changes in floor slopes, such as the ends of ramps, washes (i.e., raised areas of the deck surface), at the ends of double tees, and at handicapped ramps.
3. Impact forces caused by pushing equipment or snow into walls or spandrels should be avoided. Additionally, impact forces applied to deck surfaces caused by dumping snow into storage piles should be avoided.

4. Avoid storing snow directly over floor drains.

5. Frozen chunks of snow or ice that have fallen from vehicles should be removed daily, along with all hanging icicle formations.

Conclusion

Keeping the parking structure free of snow and ice and removing corrosive deicing salts are essential for proper performance, long term durability, and public safety. Sufficient planning, selection of proper equipment and chemical deicers, and adherence to proper procedures are all necessary ingredients for the successful removal of snow and ice.

2.3 PREVENTION MAINTENANCE

Preventative maintenance involves a periodic checkup, cleaning, and restoration of all components including structural, architectural, and mechanical elements as well as equipment maintenance and safety systems. This type of maintenance prevents premature deterioration of the structure and unexpected failure of mechanical components. Minor problems discovered and corrected with preventative maintenance will prevent expensive future repairs.

The owner has basic control over the durability of a parking structure. If the owner chooses to invest in durability-enhancing features in the original construction, preventive maintenance and future repair costs will be smaller. Therefore, it is recommended that the owner, not the operator, be responsible for preventive maintenance.

Preventative maintenance should include a yearly checkup of structural, architectural, and mechanical components to verify proper performance. For the structural system, the checkup should include a visual inspection of all structural components, preferably by a structural engineer experienced in the design and construction of precast parking structures. Of particular importance in structural system maintenance is the drainage and sealants. Over time, poor performance of these elements can lead to serious structural problems. Equipment maintenance may be performed by the owner or operator in accordance with the manufacturer's recommendations. Revenue control equipment, life safety systems, elevators, and security systems are vital ingredients for maintaining the parking structure in proper working condition. Specifically, the annual checkup involves the following tasks:

A. Structural Systems Maintenance

- **Double Tee Floor Members:** *Visually inspect for delamination, spalling, cracking, and scaling. Check flange connections for weld failures or corrosion damage.*
- **Floor and Roof Deck Members:** *Visually inspect for spalling, cracking, and scaling. For field-applied cast-in-place toppings, also visually inspect for delamination. Check pretopped double tee flange connections for weld distress or corrosion damage.*
- **Beams, Columns, and Spandrels:** *Visually inspect for spalls, cracks, and/or delaminations.*
- **Stair and Elevator Towers:** *Check handrails, stair treads and land-*