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The Inspection, Testing and Refurbishment of Multi-storey Car Parks

There is generally very little available space for parking, especially in towns and cities and as a result, multi-storey car parks (MSCPs) have become an essential part of this country's infrastructure. There are over 4000 MSCPs in the UK, almost all of which have been built since the 1940's. Many were built during the construction 'boom in the 1960s.

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"Increased prosperity in the 21st century has led car park users to demand facilities that are finished to a high standard. This emphasises the need to ensure that MSCP's are regularly inspected and maintained."

Large out of town (and in town) shopping complex construction has grown extensively over the past 30 years in the UK with a switch from High Street shopping to the ease of the 'one stop shop' approach to shopping matched with the ease of parking

With these complex buildings come particular problems that require an understanding of not only the forms of distress and remedial measures but the needs of the owners and centre managers/occupiers.

Problems with shopping centres range from water ingress through cladding, atriums, roofs etc, through to structural issues with car parks.

A great many MSCPs are reinforced concrete construction and were designed using building standards that are now outdated.

Many have a history of early deterioration due to inadequate design, poor construction and low standards of repair and maintenance. A large proportion of problems are caused by corrosion of the concrete reinforcement, often due to the deposit of de-icing salts from the tyres of vehicles using the car park during winter months. The resulting corrosion eventually causes the concrete to spall and leads to a reduction in the durability of the structure.

One notable example of the result of poor maintenance of car parks was the partial collapse of a 120 tonne section of the Pipers Row car park in Wolverhampton on the night of 20 March 1997.

Post Pipers Row

The potentially lethal collapse sustained at the Pipers Row MSCP led to the publication in 2002 of the Institution of Civil Engineers (ICE) guide Recommendations for the Inspection Maintenance and Management of Car Park Structures.

This document has been specifically written to address the important implications of the past performance of car park structures and provides recommendations for good practice for car park owners and operators and their engineering advisors.

Divided into two parts, the guide presents practical recommendations that translate into everyday good practice. Part one is aimed at owners and operators of car park structures and details the recommended principles and approaches to good management. In particular, the development and implementation of a "Life Care Plan" for each car park structure is recommended.

Part two of the guide is aimed at the professional engineering consultant and offers more detailed, technical information on the "Life Care Process" for a car park structure, for example:

- **Inspection**
- **Maintenance**
- **Repair**
- **Rehabilitation**
- **Replacement**

The guide also includes four appendices, which contain reference material on design, construction and performance; defects, cracking and deterioration, testing and monitoring; and safety risk and structural appraisal.

Life Care Plan

To produce a comprehensive life care plan, a client should consider the following:

- **Daily surveillance**
- **Routine inspections**
- **Condition surveys**
- **Maintenance/repair plans with costings**
- **Emergency failure inspections/investigations**
- **Asset management plans**
- **Future feasibility studies**

TABLE 1 : LIFE CARE PLAN

TASK	PERFORMED BY	RESPONSIBLE	PROGRAMME
SURVEILLANCE (DAILY)	CAR PARK STAFF	CAR PARK MANAGER	DAILY
INSPECTION (ROUTINE)	INSPECTOR/ SURVEYOR	CAR PARK MANAGER	EVERY 6 MONTHS
DETAILED CONDITION SURVEY	CONSULTING ENGINEER	OWNER/ OPERATOR	EVERY 5 YEARS
STRUCTURAL APPRAISAL	CONSULTING ENGINEER	OWNER/ OPERATOR	EVERY 10 YEARS
SPECIAL INSPECTION	CONSULTING ENGINEER	OWNER/ OPERATOR	AS REQUIRED

Condition Survey

The ICE report recommends that a condition survey should be carried out every eight years, in much the same way that local authorities have a duty to carry out principal bridge inspections every five years. Establishing the cause of deterioration to the structure of a car park is fundamental in ensuring the most appropriate repair and maintenance strategy is developed, not only for the needs of the structure but also for the client's budget.

Varying Levels Of Survey

Indicative
A full visual inspection will identify potential problem areas. Recommendations may involve holding repairs and the immediate removal of loose materials.

Limited
Representative areas of the car park structure identified in the visual survey are tested, along with sound areas to establish the likely extent of deterioration. Advice is given on recommended refurbishment options and costs.

Full
All elements of the car park structure are considered and all potential defects are identified and recorded on drawings. Diagnostic testing is carried out on the structure and results, along with refurbishment options and costs, are detailed in a comprehensive technical report. Diagnostic test techniques used to establish the condition of a car park structure include:

- **Hammer sounding survey**
- **Half-cell potential mapping**
- **Chloride sampling**
- **Cover and carbonation depth measurements**
- **Corrosion rate monitoring**

Maintenance and Repair Options

After the client's engineering consultant has studied the results of the diagnostic testing, a range of maintenance and repair options is available. In the case of new-build car parks, it is vital that good design principals and a proper maintenance regime are not ignored. Apart from the structural aspects of good car park design, it is vital that potentially damaging road de-icing salts (chlorides) are kept out of the concrete by the use of protective deck membranes. Anti-carbonation coatings (not masonry paint!!) will also inhibit carbonation attack of the new concrete.

In the case of the decks, a fully flexible waterproofing membrane should be applied to exposed top-decks and a similar, but less flexible, waterproofing membrane can also be applied to intermediate decks. In some instances, it may also prove beneficial in the long-term to install a corrosion prevention system within the new concrete prior to placing. The main drawback to these two latter options is that they increase the cost of the car park in what is often a cost-conscious development.

Cost Considerations

For existing car park structures, the instigation of a regular maintenance programme is often difficult due to past malaise. Often, an older car park structure will also need some form of initial work required on it to bring it up to an acceptable level, both structurally and aesthetically. Unfortunately, there are often discrepancies between what needs to be done to the car park structure and what the client is prepared or able to spend. Any recommendation that the client's engineering consultant may make needs to take this into account.

Health and Safety

The issue of maintaining a safe environment for car park users is of a great concern to centre managers who have to deal with the day to day issues in relation to safety.

More often in times of financial constraints car park owners are faced with the problem of not having funds available to carry out the necessary repair and protection works to concrete areas, yet not being in a position to close areas (sometimes entire levels) of a car park due to lack of revenue or problems associated with loss of earnings claims from tenants.

This is a very real problem when at the same time the owner must fulfil their obligations under Health and Safety legislation.

To manage this problem Make-Safe 'holding' Surveys are often a lifeline as they show the client is fulfilling their duties and keeping a car park safe to vehicular and pedestrian users whilst keeping costs manageable until a repair programme can go ahead in years to come.

The process involves an initial condition survey and report with follow on make-safe/update of previous reports on a 6 monthly or yearly basis depending on condition.

The update is important as it records the escalation of defects on CAD drawings and cross references with defect schedules and budget rated bills of quantities so the future funding amount to repair is always accurate.

These surveys (depending on car park size etc) can carry as low a fee as £3,000 - £4,000 – a small and affordable price to pay for safety!

Concluding Remarks

Increased prosperity in the 21st century has led car park users to demand facilities that are finished to a high standard. This emphasises the need to ensure that MSCP's are regularly inspected and maintained. By engaging specialist and truly independent consulting engineers that have experience of these structures, clients can be assured of truly independent and cost effective advice.

Reference:
1. INSTITUTION OF CIVIL ENGINEERS
Recommendations for the inspection, maintenance and management of car park structures. Thomas Telford. 2002. pp.112.

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