Lift Modernisation Challenges

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Abstract. Question – What are the lift modernisation challenges? Currently there are no published definitive codes, standards and not many guidelines what constitutes a lift modernisation. Based on this fact how could we have confidence that the planned lift modernisation will be safe mechanically, structurally and electrically? Also, how could we make sure that the appointed lift contractors will have the required skill sets to design and sign off the completed works?

For new lift installations, the code BS 5655-6:2011 is very specific what type of design information needs to be provided. According to this code the client's representative needs to provide various documents and information including but not limited to structural loading, vertical shaft alignments and requirements for fixing guide brackets. Unfortunately, this information exchange is not required for a lift modernisation.

For lift modernisations the successful lift contractor will also have to comply with many relevant statutory regulations. In the UK many important requirements are stated in Health and Safety at Work Act, Construction (Design and Management) Regulations and Lifting Operations and Lifting Equipment Regulations (LOLER). For every country specific and local regulations will apply.

1 AVAILABLE INFORMATION

The biggest challenge is the pressure on lift companies and lift consultants to replace older lifts with new lifts without detailed examination that this approach is absolutely necessary. CIBSE Guide D (2015) in Section 16 states "a refurbishment is usually less expensive than a full replacement but may not extend the life of a lift by more than a few years. In the long term it could be more expensive". It is not clear how this statement is justified but in the last decade we can witness reduced skill of lift modernisation labour and engineers. Nowadays, it is not easy to find lift companies who are able to engineer a lift modernisation and provide a long term life expectancy.

The Vertical Transportation Handbook by George R Strakosch states the opposite *"building management expects from elevator modernization is a major reduction in elevator downtime. This is accomplished through greater reliability of new components"*

The Lift Modernisation Design Guide (2nd edition 2017) by Roger E Howkins gives a comprehensive list of life expectances of the majority of lift components and a systematic approach to modernisation and the people who should be involved from the preplanning stage to the award of the contract and these people and professionals include but are not limited to the structural, mechanical, electrical and fire engineers.

The objective of BS EN 81-80:2003 is to try to improve the safety of existing lifts by risk assessment but does not go as far referring to modernisation – in essence it's a shopping list for minor repair to a lift which tries to bring the lift up to the minimum requirements of EN81-1 and EN81-2, however without the electrical, structural and environmental requirements detailed in BS 5655-6: 2011.

The European Lift Association (ELA) document "Safety of Existing Lifts" (March 2013) provides advise based on BS EN81-80: 2003, details of 74 risks associated with lifts in service which makes no reference to modernisation but this is more applicable as a sales tool for maintenance companies as it tries to improve the overall safety of the lift installation but not the life expectancy.

The Lift and Escalator Industry Association (LEIA) in its 2016 Focus publication states *"The complex challenge of lift modernisation was clearly identified as a hot topic"* also *"our industry has many technical roles from design and engineering to troubleshooting and testing. All these roles are of equal importance"*. There is an underlying theme in this publication for commercial considerations, CE marked components and reference to BS EN 81-20:2014, yet this is not a relevant standard for Lift Modernisations.

The Lift and Escalator Industry Association (LEIA) publication "Lift Safety in the modern built environment" – April 2017, in section "Modernisation and sustainability" references sustainability and concentrates on energy performance but not on the safety of a lift modernisation. It gives the wrong impression of what a lift modernisation should focus on. It does not increase the life expectancy of the lift installation when modernised.

2 FUNDAMENTAL QUESTIONS

What should be done with lifts installed prior to the adoption of codes or standards such as BS 2655-1: 1957? Who would be responsible for actions such as checking and verifying the structural design to withstand the loadings on the machine room slab, guide rails and fixings?

As it is very unlikely that any original design information will be available from the original lift manufacturer, architects or structural engineers therefore who would be responsible to verify the original design and check if the site is suitable for the new lift equipment?

Should the building owner accept, without further investigation, that the existing building structure, electrical supplies and the retained lift equipment are suitable for the modernised lift?

3 HOW MUCH INFORMATION IS REQUIRED AND WHEN?

With lift contractors' sales teams under pressure to maintain sales targets, it is apparent that tenders for lift modernisations are also based upon a percentage success strike rate determined by number of tenders submitted. This has resulted that the competitive bids are submitted on limited or basic surveys. When the lift company is successful, a full survey is then undertaken but with a very high risk to the client of the additional costs and programme delays due to the tender original surveys being incomplete or poorly executed.

The major risks that could be identified are, but not limited to the following:

- Corrosion of equipment.
- Guide fixings and machine slab loadings.
- Tolerance and verticality of lift shaft.
- Electrical supply loadings.
- Air conditioning refrigerants in cars and lift motor rooms.

Generally, as the design issues are not covered by any guidelines, codes or standards, many issues are usually identified during lift modernisations process. Majority of them could be addressed during the pre-tender surveys and prior to the bid submittal or being included in the project as a contingency sum.

With more lift modernisation contracts being "turnkey" the lift companies need to have more comprehensive skill sets. LEIA have stated *"our industry has many technical roles from design and engineering"* but how quickly can lift modernisation companies respond to these complex and new objectives and increase their overall skill base in the field of lift modernisations.

4 CORROSION OF LIFT EQUIPMENT

Corrosion is the adverse impact on the features of a metallic material due to the chemical or electromechanical reaction of that material with the surrounding medium.

For a potential lift modernisation the appointed lift contractor should understand the main corrosion groups: general corrosion, paint corrosion and corrosion cracks and beware during pre-bid surveys to allow for remedial works.

Ideally the designers of the original lift installation should have considered the potential areas of corrosion risk especially if the lift is an industrial, open environment or humid conditions. The lift company should also maintain the material correctly by the application of the correct additional surface coating to the component or sub assembly if corrosion is discovered.

Within the published guides, codes and standards there is no guidance on how lift components corrosion should be inspected and whose responsibility it is to treat of repair corroded components and subsystems. It is a misleading concept that the component has worked correctly since the original lift was installed, therefore there is no requirement to inspect for corrosion.

Corrosion degrades the materials surface, colour and strength but can be easily treated by the correct surface preparation and re-painting. In areas where corrosion is widespread the area should be inspected by specialist methods such as ultrasonic tests, or magnetic particle inspection. Then, the results should be compared with the original component structural characteristics. It is the lift modernisation contractor's responsibility to undertaken this works prior to commencing the job on site by inspecting the works primarily via non-destructive testing (NDT) without destroying the serviceability of any part and, if needed, employing a specialist structural engineer who specialises in corrosion.

Another area of a critical and safety risk is bi-metallic corrosion (Galvanic corrosion). This is an electrochemical process in which one metal corrodes preferentially when it is in electrical contact with another, in the presence of an electrolyte. It is most common when a steel door frame (goal post) is fitted directly on to an aluminium cill without a barrier between the steel section, fixing bolts, and the aluminium cill. This type corrosion is difficult to notice but, if existing, it would affect the overall strength of the door set. This inspection, should be the lift companies responsibly and if there is any doubt on the integrity of the sub system assembly, a specialist corrosion engineer should be engaged.

5 GUIDES FIXINGS, MACHINE BEAMS AND SLAB LOADINGS

Lift modernisation contractors need to determine when the lift was originally installed as a manufacturing data plate is not always fitted.

If the lift has Tee Guides installed it may not have been designed to the minimum safety standard but to code BS 2655-1:1957 which in terms of calculations for safety components is very basic.

It is a misleading concept that due to the fact that the guide rails have worked correctly since the original lift was installed they could be re-used without any examinations. The lift modernisation

contractor should carry out a guide rail calculation as described in BS EN 81-20:2014. This is very important, especially if new car/counterweight safety gears are being fitted as the existing guide rails may have an unacceptable deflection when the safety gear operates. When new bi-directional safety gears are considered on existing lifts, possibility of lifting guides when operates in up direction should be also analysed.

If the lift contractor carries out a detailed lift survey at the tender stage with the subsequent calculations they will be able to decide if the guide rails are suitable for reuse. In extreme cases where the guide rails are not suitable for a lift modernisation a new lift in the existing shaft will be required.

The car and the counterweight guide rails are fixed into the lift shaft wall by fixings such as “rag bolts”, welded studs or built in inserts which have unknown pull out qualities. When carrying out dynamic tests on a new “type tested” safety gear these fixings could fail and the building owner would have to pay substantial additional costs for new fixings and programme delays. This could be avoided if these concerns were identified during the pre-tender survey.

The original design assumption and calculations may not be applicable for the lift modernisation therefore many design aspects need to be investigated prior the commencement of work. Queries such as if a new drive would be required due to the lift speed increase or if a more energy efficient type of machine could be used need to be investigated at the beginning of the project.

It is very dangerous to assume that the structure and machine beams have worked correctly since the original lift installation and therefore they are correct. The possibility that there may have been calculation errors originally needs to be assumed. It is very important that a structural engineer comments on the new dynamic and static loadings and compare these with the original design.

It is common to see lift modernisation contractors fixing new lift machines to the original machine beams (bed plates) without any consideration to the design of the original machine beams in terms of deflections, twisting moments and condition of the bolted or welded fixings.

Also quite common is keeping the original machine isolation as the removal and renewal will require the existing machine beams or bed plates to be lifted. As a result keeping the existing machine isolation which may have lost a high proportion of its isolation characteristics, would not improve the noise and vibration characteristics of a modernised lift.

6 TOLERANCE AND VERTICALITY OF LIFT SHAFT

It is an assumption that the original lift shaft was constructed with tight tolerances and verticality requirements typical for new installations. For modernisation projects it is the responsibility of the lift contractor to establish the tolerances and verticality of the lift shaft during the tender process to avoid for any concerns being raised during the installation process.

As a general practice, the lift company surveyor will only dimensionally measure the lift shaft in one location and then assumes that this is a correct dimension throughout the lift shaft and only on rare occasions check the verticality of the lift shaft.

This approach doesn’t highlight the defects of the original lift shaft construction such as bowing due to concrete shuttering slipping or building settlement, shaft floor beams not aligned or other none lift related services within the lift shaft. These issues may have been permitted during the original installation and due to restraints of the building cannot be removed or repositioned. These original defects often occur when larger lift platforms are being installed or when manual car and landing doors are being replaced by automatic designs.

A “point cloud survey” replaces the traditional limited 2D survey carried out by the lift contractors. It generates a very accurate 3D model through laser technology which enables defects in the existing lift shafts by providing geometrical points. It should be required by all lift contractors to employ a professional surveyor to carry out a “point cloud survey” prior to starting any lift modernisation projects. This would eliminate many of the risks related to the lift shafts being “out of plumb” such as delays for new materials to be ordered or possible financial consequences due to programme creep.

7 ELECTRICAL SUPPLY LOADINGS

A lift modernisation will always require analysing of the electrical power supplies to the lift motors, lighting and socket outlets in the lift shaft, motor room and cars. The original lift installation electrical supply could be very old and not comply with the requirements of the proposed lift modernisation.

The lift modernisation contractor must employ a qualified electrical contractor or consultant to survey the existing electrical installation and report on its suitably for the new equipment being supplied.

This survey should include the information how the new electrical supply cable can be re-routed to comply with the current requirements and if run within the lift shaft how this will affect the safety clearances.

For safety the electrical installation isolation switches and distribution boards in the lift motor rooms may have to be repositioned to enable authorised personnel to work on them. Also, the new rubber mats, electric shock notices and danger notices need to be replaced as good practice, to not put lives at risk by having non-compliant equipment and incorrect notices fitted.

The lift modernisation companies’ responsibility is to include technical advice from a competent person to the building owner on the nominal voltage, phases, full load current and any other relevant details that may be required for lifts etc.

It is the responsibility of the lift modernisation contractor during the tender stage of the project to seek professional advice and provide the building owner with sufficient information to enable them to budget for any additional works and not be informed during the installation or testing that the electrical supply is not sufficient.

8 AIR CONDITIONING REFRIGERANTS IN CARS AND LIFT MOTOR ROOMS

The use of air conditioning in panoramic lift cars and within lift motor rooms is very common.

The air-conditioning units in lift motor rooms are normally self-contained free standing and not connected to the building air-conditioning system due to the smell of the lift drive. This can be noticeable especially when hot hydraulic oil smells are being circulated within the building air conditioning system. The self contained air-conditioning systems fitted to lift cars do not have these problems as the exhaust is vented directly to atmosphere either outside or within the lift shaft.

Within a “turnkey” lift modernisation it will be required for the successful lift contractor to overhaul or replace the self-contained air-conditioning systems. During the initial pre tender survey it is essential that a professional mechanical or refrigeration engineer is employed by the lift company to provide advice and a report on the fitted air-conditioning units.

The early involvement of a professional mechanical or refrigeration engineer not only will clarify the suitability of the existing air-condition unit but also could advise on the possible repositioning of the air flow ducting within the lift car. Within the lift motor room the air-conditioning unit may have to be repositioned due to the new equipment being installed and the existing heat generators are being replaced with new equipment.

9 CONCLUSIONS

It is apparent that for any lift modernisation the lift companies are required to adapted and increase their skill sets by employing more professional qualified engineers. The complex design issues such as original structural design, corrosion, refrigeration, electrical and mechanical design would need to be addressed at the beginning of the project. It is not acceptable to have the mindset that the lift structure, fixing and loadings have been satisfactory for 20 or more years and therefore will be fit for purpose after the modernisation.

The lift industry needs to understand the building as a whole entity and not be focused on the element which is the lift installation.

The limited publications produced by the lift industry trade bodies, guides, codes and safety standards need to reflect the complex nature of lift modernisation. They cannot be only presented as sales tools for minor repairs or upgrade due to sustainability. As the lift modernisations declare high percentage of the overall number of the lift projects they should be treated as an equal with new lift installations and become more frequently recommended as a viable option to establish long life expectancy of the lifts.

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BIOGRAPHICAL DETAILS

Roger Howkins is an Associate within the Arup Vertical Transportation team, providing advice to Arup both in the UK and overseas on the use of lifts, escalators and passenger conveyors in new and upgraded buildings. He is an authority on modernisation of lifts, escalators and external lift installations. He has experience in giving expert witness testimony in the UK and abroad.