OCR
Oxford Cambridge and RSA

Wednesday 12 June 2024 – Morning

A Level in Design and Technology: Design Engineering

H404/02 Problem Solving in Design Engineering

Resource Booklet

Time allowed: 1 hour 45 minutes

1337360426

INSTRUCTIONS
- Use this Resource Booklet to answer **all** the questions.
- You should spend **35 minutes** reading this Resource Booklet.
- Do **not** send this Resource Booklet for marking. Keep it in the centre or recycle it.

INFORMATION
- This document has **8** pages.

ADVICE
- Read this Resource Booklet carefully **before** you start your answers.

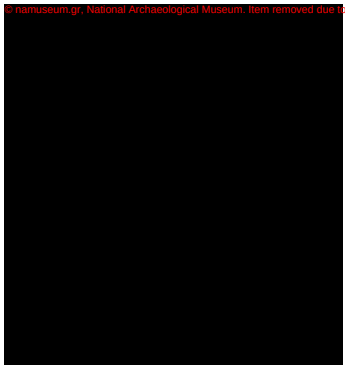
The stimulus in this booklet relates to issues and opportunities that may be encountered when designing, manufacturing and installing children's outdoor public play areas.

Introduction

Children's outdoor public play areas have brought hours of enjoyment and learning for lots of children all over the world. The design and engineering that goes on behind the development of these areas is extensive and involves various engineering fields and agencies.

The first swing was thought to have been developed in the 5th century BC. Greek artists portrayed paintings on vases of children playing on swings. Evidence of early play equipment is shown in **Fig. 1**.

Fig. 1



Since then, other civilisations have developed the concept but, essentially, the design has remained the same.

Fast forward to modern times where it is not just as simple as a piece of rope hanging from a tree in children's outdoor public play areas. The introduction of more modern materials has led to the development of a wide range of playground equipment specifically designed for younger children to safely play on. These materials have gone through extensive testing to ensure that they can withstand the harsh climates and regular use that an outdoor public play area is exposed to throughout its lifetime.

Stakeholder Considerations

There are a range of stakeholders involved in the design, manufacture and running of an outdoor public play area. These stakeholders must adhere to tight safety regulations to ensure that what they supply and install are safe for the users and the people around them. Each year, there are approximately 40 000 injuries to children in outdoor public play areas that result in hospital visits. The reasons for these can be separated into two main causes – management causes and user causes. Management causes refer to the installation, design and maintenance of the play equipment as shown in **Fig. 2**. User causes refer to the incorrect use of the equipment, incorrect clothing, lack of supervision or using the equipment in poor weather.

Fig. 2

If an outdoor public play area is deemed unsafe then a Play Area Manager may be sued for negligence. There are many Acts of Parliament that govern these outdoor public play areas ranging from the Occupiers' Liability Acts 1957 and 1984 to the Health and Safety at Work Act 1974.

However, the most important document for any designer is the British Standard EN 1176 which covers equipment in outdoor public play areas. This document covers all types of play equipment and surfacing. It outlines the minimum requirements for a piece of play equipment which would be applied to a product such as that shown in **Fig. 3**.

Fig. 3

Case Study: Cotton Mill Park

Many play area design companies look at the development of public play areas and make them an extension of the environment that they are set in. This leads to designs being either one-off or produced in small batches. Below is a case study for a community park designed specifically for a customer's needs.

The Customer

Located west of Leicester, Hampton is a small town that needed a community park and a landscaped area containing paths, trails and play areas where residents and visitors can relax and engage in recreational activities and play. The old and vacant cotton mill that had not been in use since 2000 was removed to make room for the new Cotton Mill Park. Through a joint community partnership the county developed the park and the residents in the community helped raise funds. Construction of Phase 1 began in 2014 and included design of the land, trails, car parks, flagpole and signs. Phase 2 included the addition of a number of play areas which were completed in September 2017.

The Challenge

The county recreation department needed a series of play areas that met the needs of the community. It was in search of durable and long-lasting playground equipment that met the appropriate ages and developmental stages of all children. Ease of maintenance was important and it wanted designs which blended aesthetically with the environment. The community felt the play areas were one of the most important components of the new park. A spokesperson from the county recreation department said, 'It would offer secure places for children to play and attract families to the new park.'

Proposal

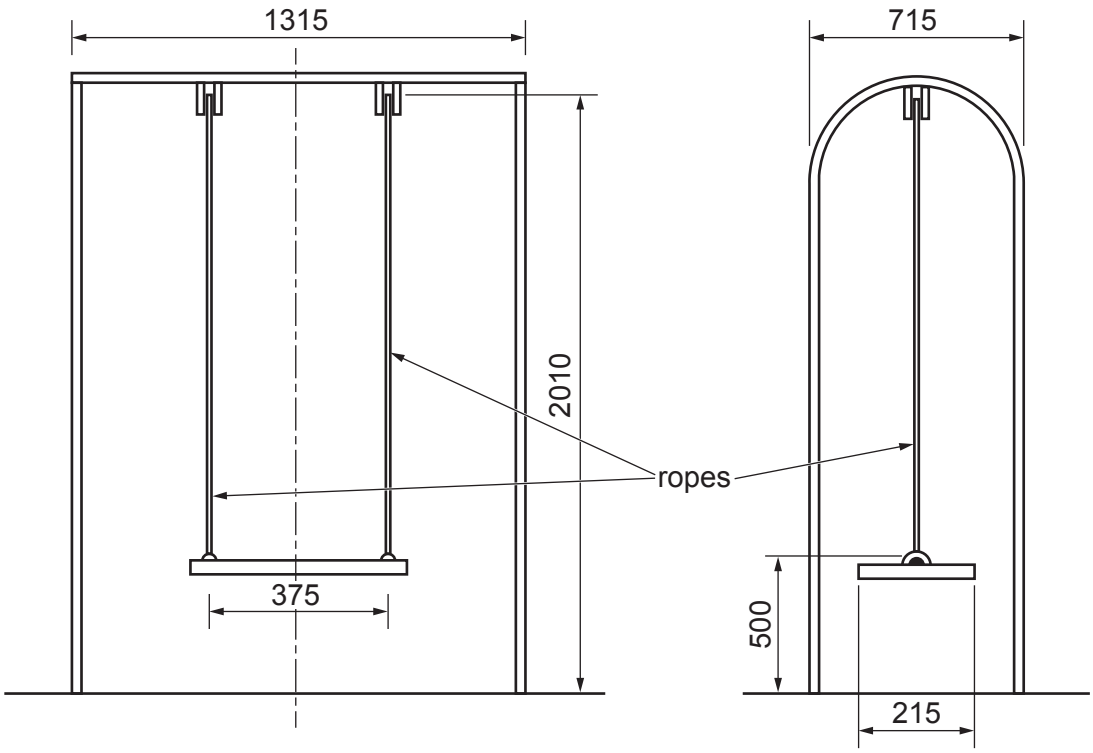
One of the proposed play area installations is shown in **Fig. 4**. It consists of two play structures, independent play items and site furnishings. The entire play environment was designed with a natural colour scheme. The designers chose to use recycled polymer for some of the parts because it offers the look of wood without the unwanted maintenance. Each structure would be a modular design and would include slides, climbers, roofs and interactive activity panels. These would be taken from the design of existing equipment but modified to meet the aesthetic needs of the Hampton area. Surrounding the play area were site furnishings including benches and portable tables.

Fig. 4

Swing Design for Cotton Mill Park

Fig. 5 shows the design of a single swing which will be located in one of the play areas in Cotton Mill Park. All dimensions are given in mm.

Fig. 5



(not to scale)

Rope Specification

Designers propose to use the rope in **Fig. 6** for the swing. The rope is made from recycled polymer bottles. It has good abrasion resistance and shock absorption. It is soft and flexible with good UV resistance.

Fig. 6

Rope Specification
100% recycled polyester yarns (rPET)
Rope diameter: 12 mm
Young's modulus: 480 MPa
Density: 1.38 g / cm^3
Washable at 30 °C

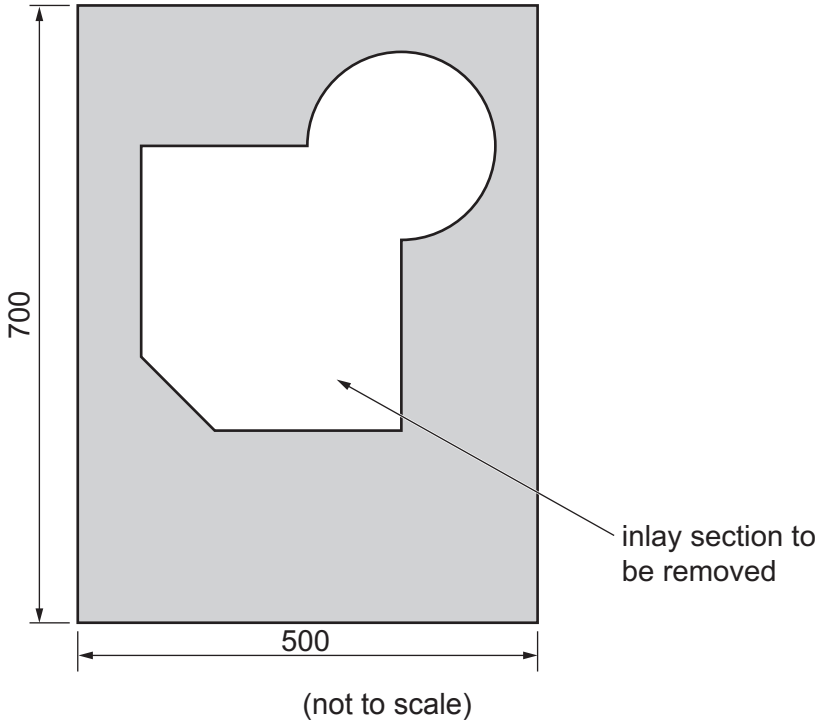
Decorative Panel Design

Parts of one of the play areas installed in Cotton Mill Park will have decorative panels inserted. The design of one of these panels is shown in **Fig. 7**. All dimensions are given in mm.

The panels will be cut from 12 mm thick aluminium sheet.

The panels will be cut out using a CNC plasma cutter.

Fig. 7



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MolsCat CNC Plasma Cutting Machine

Fig. 8 shows the specification of the MolsCat CNC plasma cutter.

Fig. 8

Specification	
Plasma output	30–130 amps
Cutting speed @ 8 mm thick aluminium	0.7 m / min
Cutting speed @ 12 mm thick aluminium	0.6 m / min
Cutting speed @ 20 mm thick aluminium	0.5 m / min

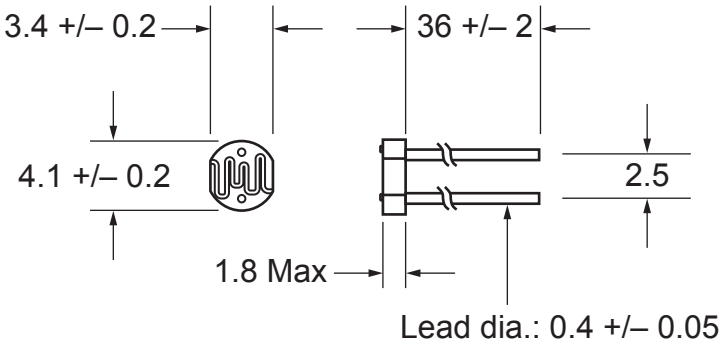
MB400 Play Area Gate

There are also plans to install gates around some of the play areas in Cotton Mill Park. The MB400 gate in **Fig. 9** conforms to BS EN 1176 to create safe access points to play areas. The MB400 gate has a soft close feature which ensures that it returns to the closed position after use. This preserves the integrity of the play area perimeter and prevents the slamming of the gate and trapping of fingers.

Fig. 9

NSL-19M51 Light Dependent Resistor

Fig. 10



Dimensions in mm.

Parameter	
Dark resistance	10 MΩ
Resistance at 10 lux	20 kΩ
Resistance at 100 lux	5 kΩ

LA080Z Linear Solenoid

Fig. 11

Parameter	
Nominal voltage	12 V DC
Nominal stroke	8 mm
Initial force	12 N
Securing footprint	30 mm × 40 mm

Sustainability when Designing and Manufacturing Outdoor Public Play Areas

Creating a children's outdoor public play area from environment-friendly materials benefits everyone. Play equipment manufacturers are exploring a range of alternative materials.

Plastic Containers

Used polymer containers can be recycled for the manufacture of playground equipment. The used materials go through a process of sorting, shredding and cleaning before being processed into new products. During the re-manufacture process colour can be added and surfaces can be given a texture or pattern to make them non-slip and to improve aesthetics. As well as moulding specific playground equipment parts, recycled polymers can be turned into general construction materials such as planks and poles, simulating the traditional use of timbers. Rolls of artificial grass, ropes, nets and components such as brackets and fixings can all be manufactured from recycled polymers.

Car Tyres

Children love to climb, run and jump. Unfortunately, their sense of danger is not well developed and falls and bumps inevitably happen. In the past, play area floors were made from concrete or tarmac. These hard and unforgiving surfaces resulted in some serious injuries. For a period, sand or wood chips were used as a safer alternative but the trend now is to use old vehicle tyres, shredded into loose rubber chips (called a rubber mulch) or to further process them into rubber tiles. A bespoke play area floor can be made by mixing rubber granules with polyurethane resin and wet pouring this directly onto a prepared surface. This allows the designer to include colours, patterns and graphics on the play area floor.

Sustainable Timber

Timber grown in sustainable forests is an important source of material for the construction industry. Whether such timber can be considered to be environmentally friendly and carbon-neutral depends to a large extent on the energy used to fell the trees and process the timber and the inevitable fuel used to transport timber large distances from Europe and beyond.

An alternative is to use reclaimed timber and to upcycle it into new products such as those used in play areas. Properly treated and maintained timber can have a long serviceable life contributing to a sustainable plan. It can add an element of individuality to a new development, especially if the timber has an interesting history that can be authenticated. Railway tracks were traditionally laid on large wooden 'sleepers' but these are being replaced by concrete alternatives. This has resulted in old sleepers that can be bought for reuse in modern construction, landscaping and furniture projects. An oak sleeper can be expected to last more than 100 years outdoors. The naturally weathered appearance of an oak sleeper brings a unique look to a modern build.