Development of the UK Government's support for Construction-related Research in the 20th Century: the role of the Department of Scientific and Industrial Research

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Introduction

The study of the history of construction of the UK in the 20th century has many contexts and viewpoints but one aspect, now almost out of living memory, is that of a particular model of state support for research in the building-related industries. From the First World War until the privatisation of the Thatcherite era, there was a wide spread of funding for both state-run and industrial associations' laboratories, driven by the government's Department of Scientific and Industrial Research (DSIR) [1].

This support for the construction-related industries was literally foundational for most of what was built in the 20th century. The Building Research Station (BRS), still in action today as the Building Research Establishment (BRE), emerged from the preparations for reconstruction after the First World War and was also a crucial player in reconstruction after the Second World War. Other construction-related government establishments, and the many industry-funded research associations, most of which have faded from view, were, in their time, central to the development of the UK's research infrastructure. The trigger for this plethora of organisations was the realisation that, although the fundamentals of structural and civil engineering were well understood by this time, very little basic science had been done on materials, processes and systems used in any branch of construction. The government officially encouraged the blossoming community of industrial laboratory associations and also put significant funding into its own network of laboratories. The paper will not cover the research work undertaken in universities nor that in the private in-house laboratories which many larger companies maintained, but will summarise the histories of how these government and association laboratories came into being and how they interacted.

The Department of Scientific and Industrial Research (DSIR)

In 1915 the experience of developing and producing the materials and machinery needed to fight the First World War alerted the UK government to the nation's previous dependence upon foreign expertise in both research and manufacturing, as well as raw material sourcing from overseas. Whilst there were already some establishments supporting military research needs, any industrial needs were often just 'bought in' from abroad. It was considered that there were "… startling deficiencies in the set up of private endeavour..." [2]. The Department of Scientific and Industrial Research (DSIR) established for the "….application of science to industry..." [3], was the outcome of the report on this problem by Sir William McCormick. The DSIR, established in 1916, continued in this role, facilitating the links between government, science and industry, until 1965 when its functions were distributed to the UK's sectoral research councils and a variety of other government bodies. It covered all fields of pure and applied sciences and all industries, from the primary and extractive to secondary production, services and manufacturing. In the privatisation of government services and agencies in 1997 all the remaining research establishments were put into the private sector.

In the UK civil service, the numbers and grades of permanent employees agreed with the Treasury as being correct for a particular department or organisation are known as the 'establishment'. Deciding on this for the government research

organisations was problematic throughout the whole 80 years that they existed. Naturally, they started small, usually led by a senior civil servant who was from the, then entirely male, administrative (non-scientist) ranks. In the early days there were explicit restrictions on employing women in some of the establishments, with even ordinary clerical work only being officially open to them on a temporary basis, perhaps due to the post-war pressure to provide male jobs. Hutchinson's comparisons of status and pay of the two 'classes' of civil servants, administrative and scientific, show how the former's higher status was a persistent problem, even though the supervising Boards were generally made up of scientists or industrialists and even when the directors of establishments complained at the difficulty of recruiting and retaining suitable staff. Staff were paid well below the 'market rate', i.e. what they might get at a university or in industry and were not uniform with the longer-established National Physical Laboratory (NPL) which was considered to employ a more 'academic' type of person.[4] This would continue to be a problem for all the government funded research establishments.

Government research establishments

Fuel Research Station (FRS)

The Fuel Research Board and its Station were the first of the government-run research organisations to be set up, in 1917 and 1918 respectively. The urgency was driven by the need to identify new UK coal seams and make best use of coal as the UK's principal source of energy. The research station was initially beside a gas works in East Greenwich, which was appropriate given that all heating gas then was made from coal. In due course there would be research laboratories in the 9 major coal areas and the industry itself set up major research establishments of its own. Methods of making oil from coal was an important part of its work, as there was then no expectation that the UK would eventually have access to its own mineral oil resources.

Its relevance to the construction industry arose through its work on domestic fuel economisation (Fig.1) and the reduction of air pollution, initially in conjunction with Dr Margaret Fishenden's work at the University of Manchester, which linked it with the Building Research Station's work on heating and ventilation. Both pollution and heating efficiency continued to be key work for all these research laboratories. An unexpected outcome of fuel-efficient stoves and fires was that their fumes condensed within cooler chimneys resulting in acidic deposits which destroyed the mortars and also made stains on the interior plasterwork, which proved to be a continuing problem for householders, plasterers and painters.

During the Second World War, the FRS was involved in work directly relevant to the war [5] developing incendiary mixtures for defensive 'Flame Fougasses' (a network of 50,000 40-gallon drums full of tar-lime petroleum gel intended to explode burning petrol over attackers), tank-borne flame-throwers and layering oil and coal dust on river and dock waters for camouflage purposes [6]. As with the BRS, the wartime work on domestic fuel use was restricted to planning for post-war reconstruction, e.g. for a new Calorimeter Building (at Greenwich) for testing heat flow through spaces and walls, from new appliances.

When the coal industry was nationalised in 1947, the coal-related component of the FRS's work transferred to the National Coal Board, as similarly the nationalised gas boards took over gas-related research. The Greenwich site closed in 1957 (now the site of the Millennium Dome) and the work moved to the Warren Spring Laboratory, Stevenage, where its initial brief was to work on oil from coal and on reduction of air pollution. In 1994, when the other similar government establishments were privatised, this too was closed with most work ending up within the Atomic Energy Agency.

Figure 1. Fuel Research Station domestic heating appliances laboratory. Photo: Public domain [6]

Building Research Station (later Establishment) (BRS/BRE)

In 1917 a Ministry of Reconstruction was set up in order to plan for the post-war era, with a particular emphasis on housing and the structure of the building industry. The popular slogan of the period, "Homes fit for heroes", carried a public expectation of vast amounts of affordable house building of a high quality [7]. The Tudor Walters Report, which laid the foundations for better publicly-funded housing for the rest of the 20th century, also set ambitions for quality and quantity which the construction industry was ill-equipped to provide. The war-time Building Materials Research Committee recommended a permanent solution in the form of a Building Research Board (BRB), established under Lord Salisbury in early 1920. The BRB moved swiftly and the first Building Research Station was set up in a group of huts and a marquee at East Acton in 1921, under the direction of H.O. Weller who had been running forest products research for the Indian Government.

In 1924 Dr Reginald Stradling took over from Weller and oversaw the move to larger permanent premises at Garston in the following year [8]. The demands on the BRS grew in quantity and breadth, initially general research into the science of building covering the efficiency of buildings, weathering, materials and structural strength. However, it soon expanded into the physics of buildings (heating, ventilation, acoustics, lighting, meteorology), the chemistry of building materials (cementitious materials, clay products, stone, bituminous materials, paints, floorings) and engineering (concretes, piling, bridges, vibration, soil mechanics, fire resistance). In many cases, e.g. the Soil Mechanics laboratory founded in 1933 (by which time BRS was under the directorship of Robert Fitzmaurice), the facilities set up for these investigations were the first of their kind in the country. Later, it widened its field of investigation to include the social sciences of method study, and consumer requirements. [9]

The BRS was also expected to undertake contract research for companies and to answer questions which did not require any significant research, from its developing body of knowledge. Its intelligence and special investigations division provided an information bureau for the industry, examined building failures and produced publications. The latter soon included involvement in the development of British Standards, codes of practice and the vast range of briefings and digests. The annual reports list special reports, technical papers and journal articles by staff, the latter rising from 27 in 1931 to 73 in 1955, but the BRS/BRE Digests came to be the most ubiquitous outputs, libraries of which were to be seen in architects' and contractors' offices.

Lea's official history of the BRS was published in 1971, detailing how and why it was set up and the principal research findings to that date. However, Lea's short chapter covering the period of the Second World War explicitly glosses over most of the war-related work, other than a brief mention of the concrete jigs developed to assist in the bending of plywood to make the Mosquito and Hornet aircraft. This is unfortunate since a fascinating project the Station was asked to assist with, in the greatest secrecy, was Operation Chastise, which was the development of the now-famous 'bouncing bombs' for the Dambuster bombing raids on the Ruhr industrial area. The BRS was also asked to look at the design of air-raid shelters, the effect of fire and explosions on structures, and the development of concrete railway sleepers [10].

Lea's view was that the most important work done during the war was preparation for post-war reconstruction, especially to replace the mass destruction of housing, which culminated in the 1944 Housing Manual. The BRS undertook a lot of work for local authorities to try to find cheaper and quicker materials and methods to build houses, schools and hospitals, urgently needed in the post-War era, but to little avail: no 'magic solution' came to light. Even in 1972, when Lea was writing, many of the systems which seemed promising, such as prefabricated panels, were no quicker in producing the final result, and the Ronan Point disaster of 1968 already exposed some systemic problems.

However, the Post-War history of the BRS/E was one of massive growth in staff, facilities and budgets as it pursued completely new lines of research into social, economic and managerial aspects of the building industries. It also cooperated increasingly with new industrial research groups, universities and international bodies, including many in the Commonwealth countries. A 1964 report for the Ministry of Public Buildings and Works noted that £3million pounds a year was being spent by the government on building research by BRS, universities and the industrial associations [11]. Whilst still noting that construction firms individually remained apathetic about research or changing traditionally practice, the working party nevertheless recommended that the industry as a whole should be taking more financial responsibility for its own research. That at a time when every metric showed that the construction industry's R&D spending was by far the least of any of the UK's industrial sectors, largely due to its systemic fragmentation. After the DSIR's responsibilities were redistributed in 1965, to the Ministry of Technology and Science Research Council, there was a gradual decline, accelerating in the Thatcherite era of privatisation, with the BRE gradually absorbing some of the other laboratories. Atkinson [12], writing at this turning point, summarised the BRE's history and highlighted how its own work, and that of the FRS and FPRL which it had absorbed, under state control had the benefit of being able to take the 'long view', build up significant archives. He was worried that the BRE properties might be sold for housing developments and that the expertise would be split up and lost in the government's explicit wish to optimise return for the tax-payer.

Roger Courtney, Director of the BRE when it was fully privatised in a not-for-profit type of 'management buy-out' in 1997, accurately read the political pressure of the time to move away from government finances and scientific priorities, towards commercial work, even if it was not popular within the industry [13].

Case study of BRS/BRE work: Reinforced concrete

Reinforcement in concrete had, of course, been in use long before the BRB came into being but even 10 years later the London County Council was feeling the need for official guidance on the use of reinforced concrete in building, to sit alongside the recently published Code of Practice on the use of structural steel. Despite the limited terms of reference of the Reinforced Concrete Structures Committee (RCSC) which was set up in 1930, that they would not concern themselves with anything beyond advice on best practice and not get into legislation, standards or specifications, it would not be long before the BRS was doing exactly that. The forerunner of the British Standards Institution, the Engineering Standards Council, had been producing standards since 1903 and their most popular early standard, BS12 on Portland Cement specification was published in 1904 [14]. Despite the evident widespread use of cement in mortars and concretes, scientific knowledge of its chemical behaviour with reinforcement was particularly lacking. Work commenced with surveys of codes of practice in other nations, supported by continuing fundamental work on such matters as temperatures within maturing concrete masses, creep and the development of standard strength tests. As soon as 1933 the RCSC was able to make recommendations for the code of practice. It will be no surprise that reinforced concrete research continued to be a major part of the BRS/BRE's work, with the 1938 BRB Report listing a number of papers on such matters as performance of reinforced concrete piles, columns and beams, but the basic science, e.g. of freeze-thaw cracking of concrete dams, was still causing concern in the 1955 BRB Report [15] (Fig.2), and in the 1964 BRB Report work on reinforced concrete for use in nuclear power station engineering was listed.

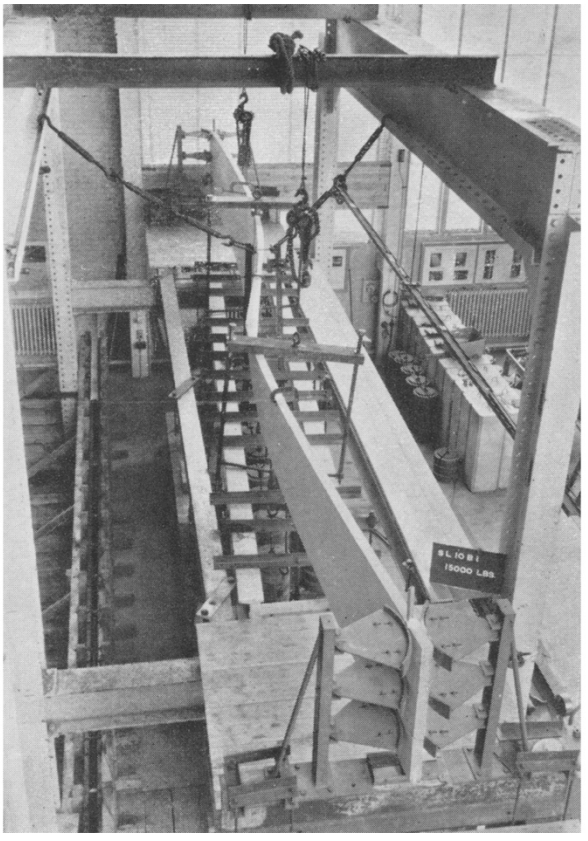

Figure 2. Testing slender reinforced concrete beam. Photo: Public domain [15]

In a curious link between the RAF, the BRS and the Fire Research Station, the wartime Ministry of Works requisitioned a 1930s hotel, the Thatched Barn, at Barnet in North London to be used as a Field test Unit for larger scale model research. The FTU's wartime work included preliminary tests for the famous Dambuster 'bouncing bombs', utilising the hotel's outdoor swimming pool, and later building model concrete dams, the remains of one (Mohne Dam) being kept at Garston for many years. At the same time the top-secret Special Operations Executive were also using the hotel to train its agents for their infiltration tasks in occupied Europe. In the 1950s the FTU site was granted £40k to develop its abilities to do concrete tests, and in 1956 it was de-requisitioned when replacement concrete testing (and other) facilities at Watford were funded [16].

Forest Products Research Laboratory (FPRL)

Although the Forest Products Research Board was set up in 1921, it was the 'guest' of the Royal Aircraft Establishment (RAE) at Farnborough until it got its own laboratories at Princes Risborough in Buckinghamshire. The impetus to set up the FPRL was a motion passed at the 1920 British Empire Forestry Conference and the connection between the Empire (later the Commonwealth) as suppliers of timber and customers for data on the treatment and uses of wood continued to be important, with staff moving between the UK and India in particular at various times. An important area of research was the best methods for kiln-seasoning of timber and development of chemical treatments for fungal and insect pests.

Transport and Road Research Laboratory (TRRL)

In 1930 the Ministry of Transport set up a Road Experimental Station at Harmondsworth, Middlesex, which was transferred to the DSIR in 1933, becoming the Road Research Laboratory, overseen by a Road Research Board. Even at this early stage the RRL was working to prepare for the coming war, looking into airstrip construction methods and the penetrative effects of projectiles [17]. The general work was mainly on materials and methods of road construction, although initially materials testing was done at the National Physical or Chemical Laboratories. As with the BRS, the RRL's war time work was mainly on civil defence needs but it also assisted with the test programme for the Dam Buster bombs. However, time was found to develop a test for the resistance to crushing of coarse aggregates, a key element in road surface durability [18]. Following the war, the work expanded to include road safety and a Traffic and Safety Division was set up at Langley Hall to the West of London, undertaking new work such as vehicle safety tests and trials of new road markings, lighting and signage. In 1967 it moved to combined facilities at Crowthorne and 1972 it became the Transport and Road Research Laboratory (TRRL), adding a wide range of other topics, including the study of public transport, environmental effects and driver behaviour. Construction-related topics included skid resistance, road materials, methods of construction, outcomes including roundabout designs and road surfaces that made less noise. As with the other government research establishments it was privatised in 1996.

Fire Testing Station (FTS)

The very first fire testing station was set up by the insurance industry's Fire Officers' Committee in 1909 in Manchester, but a more substantial national FTS was established at Elstree, Hertfordshire in 1935, when the DSIR and the Fire Officers joined forces. During the Second World War this work was done by the Fire Research Division of the Ministry of Home Security, itself taken over by the DSIR after the war. The Joint Fire Research Organisation of the DSIR and all those insurance companies, and mutual societies with fire interests, combined their resources to establish a new Fire Research Station at Borehamwood from 1949 until it was absorbed by the BRE in 1994.

As with other areas of construction-related fields, surprisingly little fundamental knowledge existed on the science of fire and the FRS did important work on the behaviour of fire and smoke, building full size, multi-storey buildings for the purpose. This work established such basics as the effects of toxic fumes from burning household items and building materials, whether sprinkler systems would disperse smoke and the flash-over effect when intense heat suddenly ignites everything in a space [19]. Even more basic data such as flash point temperatures of mixtures of normally non-combustible with combustible liquids had to be established. That fire fatalities are nowadays comparatively rare in the UK can be attributed to this type of work. Experiments in the behaviour of smoke and flames in multi-storey blocks of flats were undertaken and informed the original designs of such blocks.

Industrial research establishments and associations

In 1918 the DSIR set up its Imperial Trust for the Encouragement of Scientific and Industrial Research, more usually referred to as the 'Million Fund' [20], from which industries could apply for money to run collaborative research associations. The money was in the form of 'matched funding' which was proportional to funds raised by the organisation from its members, although grants for special equipment were also possible. This generous budget, with few constraints as to how the associations should run themselves, had run out by 1932 and was topped up (Fig. 3) by the government annually until 1971, latterly also being open to similar organisations throughout the Commonwealth nations.

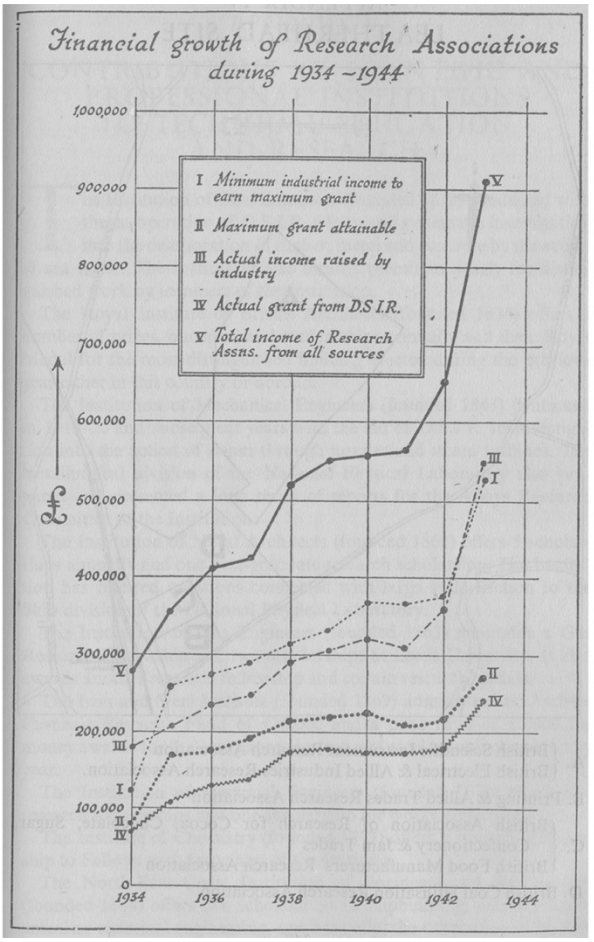

Figure 3. Heath & Heatherington page 347 [2]

In 1945 the government was supporting 25 research associations only 7 of which could be thought of as having a connection to construction [21]. However, by 1962 [22] a total of 52 associations were receiving grants, of which the 1964 Report on the Building Research and Information Service considered the following to be doing work which related to building:

1. British Cast Iron Research Association.
2. British Ceramic Research Association.
3. British Coal Utilisation Research Association.
4. British Electrical and Allied Industries Research Association.
5. British Glass Industry Research Association.
6. British Iron and Steel Research Association.
7. British Non-Ferrous Metals Research Association.
8. British Welding Research Association.
9. Chalk, Lime and Allied Industries Research Association.
10. Civil Engineering Research Council.
11. Heating and Ventilating Research Association.
12. Research Association of British Paint, Colour and Varnish Manufacturers
13. Research Council of the British Whiting Federation.
14. Rubber & Plastics Research Association.
15. Timber Research and Development Association.

Note how few of the above associations' fields of interest seem directly related to construction. This had been an issue from the earliest days of DSIR support, and relates to the fragmented nature of the building industry, both in scale (few large companies but thousands of tiny firms) and in function (materials, component manufacture, transportation, implementation) and is why the majority of such work was concentrated in the BRS/BRE and similar.

The 1964 Report consulted a vast number of other professional and trade bodies, acknowledging that they too did relevant research but were entirely self-funded at that time. This was an era when every product and industry seemed to have its own association and many of them were involved in the price-fixing cartels which were legal until 1957. There were, for instance, 13 such associations just for bricks and tiles and another 24 for other materials used in the building trades [23].

Case Study: Chalk, Lime and Allied Industries Research Association (CLAIRA)

Of the research associations examined in John Bennet's 2012 thesis [24] and in the 1964 Report), the association with seemingly the most obvious link to the building industry was the Chalk, Lime and Allied Industries Research Association.

Its origins were in the whiting industry, whose British Whiting Federation (BWF) was formed in 1943 by amalgamating the regional Whiting Associations. Whiting in this context is calcium carbonate, often chalk. The post-war encouragement for industrial associations led the BWF to set up a Whiting and Industrial Powders Research Council and laboratories at Welwyn Hall in 1947. Its work focussed on establishing the scientific basis for using whiting as a filler in such varying industries as rubber, linoleum, paint and wallpaper. CLAIRA was founded in 1955 and amalgamated with BWF in 1964 to form the Welwyn Hall Research Association (WHRA). The laboratories' work was also linked to other industries, such as papermaking and food, but on the construction side its fundamental research included glazing putties, sand grading [25] and mortar testing [26]. The CLAIRA/BWF amalgamation was short-lived and WHRA folded in 1973, with the BWF becoming the British Calcium Carbonates Federation (BCCF) in 1989 and reverting to its earlier focus on non-construction uses of powdered limestones, marbles and chalks [27].

Hence this multi-named research organisation was, like many others in the post-war period, encouraged into being by the UK government's pro-active support, but its construction-related work later withered.

Discussion

In the century since the DSIR and its various governmental research establishments and supported industrial associations started work, their ways of funding and undertaking the essential research that supports the safety and efficiency of construction have reflected the cycles of political ideologies. The initial years were ones of a socialistic-type government intervention, direction and support, commencing when David Lloyd-George was the UK's Prime Minister (1916-22). Although the spending cuts of the Great Depression in the 1930s were difficult for all organisations relying on state funding, the 'Million Fund' for collaborative industrial research associations was topped up from time to time, demonstrating that the scheme had cross-party parliamentary support for what they achieved, even though some associations closed. Those years did not see a diminishing of outputs from the civil servants in the Research Stations, as the pressure to find cheaper alternatives to traditional materials and quicker construction methods was even more acute. The years of (and before) the Second World War certainly saw some diversion into war preparation and work explicitly supporting the war effort, both on the defensive and offensive sides, but also the lesson, from the First World War: of the need to prepare thoroughly during the war for after the war, had definitely been learnt and implemented. This led to the burgeoning of yet further state direction, funding and intervention even in the difficult years of the 1950s and 60s before the Thatcherite era led to full privatisation of all the organisations in the 1990s. Very few of the former collaborative industrial research associations still exist under their original names or functions and the remaining construction-related government research establishments, other than the Building Research Establishment, either closed or merged. There is scope for further research into the histories of the many construction-related associations of the mid-20th century, both of the research association type and the trades' associations.

What seems not to have changed, despite some state funding for 'knowledge exchange' programmes to link universities and industries, is the fragmented nature of the construction industry and the consequent continuing need for the Building Research Establishment's services, albeit on a paid-for basis.

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