

The application and inspection of protective coatings on structural steel

by

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Mr N. A. Bennett (Armour Works, Wednesfield) wrote that the Author had done good service to fabricators and indirectly to owners of steel structures by reminding them that paint in the can was not the end product and that the manner and the conditions under which it was applied could have a profound influence upon its performance.

43. In commenting on the briefing of inspectors, the Author failed to recommend that the inspectorate should be under independent control and not be an adjunct to the fabrication department. Even so, the influence of a keen independent inspector could be much diminished unless he had the support of the fabricator's higher management; his job was made inordinately difficult under the conditions of the second clause in § 4.

44. The suggestion in § 20 that the inspector should "... perhaps feel that the roughness is of the type required ..." was a little dangerous; in doing so he might contaminate the surface with natural grease. A preferred method of comparison between the roughness of the blasted surface and, say, grade 00 emery paper (§ 18) was to take rubbings on thin paper with black cobbler's wax.

45. Would that magnetic thickness-meters were as satisfactory for the determination of paint-film thickness on grit-blasted or metal-sprayed surfaces as the Author suggested! In the absence of a satisfactory mechanical method of determining paint-film thickness on these surfaces, it was preferable to rely on limitation of spreading rate of the paint as a means of ensuring adequate thickness.

Mr J. R. M. Carr (Engineer, Lawrence-Colebrook [Construction Equipment Co. Ltd]) wrote that in § 41 that the Author stated that "Failure and eventually higher costs result from acceptance of the lowest tender irrespective of the maintenance of standards". With this statement Mr Carr felt bound to disagree. There were two different cases which could be examined.

47. In the first case let it be imagined that a client with a painting contract to let invited a number of contractors, all with good reputations, to tender. If, when the tenders were examined the lowest was rejected on the above premise then money was surely being wasted. If a client or his advisor selected his tenderers with care then their tenders could be compared directly and the cost of inspection considered to be static.

48. In the second case, consider a painting contract which was advertised in the press and open to all. Provided there was a full, detailed, legal and binding contract and specification for the preparation, paint, application, inspection, powers of the inspecting staff and time of completion, the client should be able to select the lowest tender, adding to it a sum for comparison's sake to cover the extra inspection considered necessary. If the client was unwilling to do this (and it would appear from the Author's statement that he would support him), then it could only be for one of three reasons:

- (a) The client did not believe the contract to be watertight.
- (b) The client did not believe that the inspecting staff were sufficiently rigorous.
- (c) The client did not believe that the contractor's assets were such that they would be able to complete the job in accordance with the specification.

49. If the beliefs (a) and (b) of this imaginary client were true and were widely held then either Chartered Civil Engineers were not being employed to advise clients and look after their interests or the Chartered Civil Engineers were falling below their professional standing, a hypothesis which Mr Carr trusted was not true. Belief (c) was a matter of establishing facts as far as possible by visiting Bush House and examining the company's papers.

Mr V. E. Stanbridge (Director, W. S. Atkins & Partners) wrote that Mr Ballard had dealt very adequately in his Paper with the subject, particularly when the conditions were ideal and when the specification could be followed regardless of programme. Seldom, however, were these ideal conditions realised in practice. Indeed, the very specification itself was often a compromise between what was ideal and what was practical or, in fact, what the client was prepared to pay for.

51. On the average contract it was not possible for the inspector to insist on examination of each stage of the work before allowing the next stage to proceed, without being held responsible for delaying the contract. Often the inspector relied for his efficacy on the salutary effect of the painters not knowing when he would appear, rather than on his ability to examine every section of the work. It became a part of his expertise, therefore, to know where it is most important for him to concentrate his activities and also to acquire a knowledge of the places where lay the greatest incentive to the painter to skimp his work.

52. In § 27 the Author mentioned the risk of delay between the application of priming coat and undercoat, particularly in conditions of exposure to salt-laden atmospheres. There was a further danger in this type of delay in any atmosphere when the primer used was based on a zinc chromate pigment. Exposure of such a primer to inclement weather conditions would result in leaching-out of the pigment, rendering the primer useless for its purpose although the coat would appear sound in other respects. Where such conditions had been known to prevail the inspector should be on the watch for signs of leaching-out. These would take the form of chromate staining on the surrounding works particularly at the bottom of stanchion stalks.

53. Mr Stanbridge was a little puzzled by the Author's statement in § 11, that mechanical brushing did not seem to be as effective as hand brushing. Where scale was firmly adherent neither method was effective. Mr Stanmore was quite certain that towards the end of the working day the operator wielding the power tool (provided it was a well-designed one) would be much more effective than the man using the hand tool, because the fatigue of the latter man would be much greater. Mr Stanbridge assumed that both men were conscientious workers.

54. It was practically impossible to overestimate the importance of keeping the time between the cleaning of the steelwork and the application of the primer down to a minimum and, in the planning of his work, the inspector should ensure that whatever other delays may occur there should be no delay at this stage.

Mr H. K. Arnold (Senior Engineer, Sir William Halcrow and Partners) wrote that it had been his experience that a preliminary inspection of workshop facilities was advantageous before a contract was placed or at least before any large scale preparation was carried out. In this way some agreement could be obtained in arrangements to establish a production routine that would fit in with required inspection.

56. Inspection during all stages of application of a protective system was essential in order to reduce to a minimum the risk of faulty application causing a subsequent breakdown. It did not follow, however, that this inspection, which included much in the nature of workshop supervision, must be carried out by the engineer.

57. If the engineer responsible for the design of a structure and for the basic specification were also responsible for a comprehensive inspection service then some difficulty in combining the manufacturer's programme with the demands of the inspector could arise, possibly leading to perfunctory inspection being carried out as was mentioned by

the Author. If the manufacturer was to provide comprehensive inspection then, subject to overall approval of the engineer, he would remain responsible for providing an efficient integrated programme which included a proper allowance of time for inspection.

58. The Author stated that all contractors of repute had their own inspection staff, maintaining the excellence of their own products. Although manufacturers might be increasingly aware of the need for proper inspection it had not always been found that the end product from a reputable firm was adequate unless independent inspection has been arranged. Such an arrangement could approach the ideal and a recognized system for manufacturers to inspect and retain responsibility for their products should be arranged. Some paint manufacturers, being similarly anxious about the proper use of their products, would independently visit workshops to see that the conditions under which their products were applied were satisfactory.

59. It was of course necessary for the engineer to appreciate the value of inspection when comparing quotations or tenders from different firms, some including inspection and some not. A firm should not feel that its tender may not be competitive simply because it had included an allowance for a first-class system and control of inspection.

60. The engineer could ask a firm to submit a tender stating a percentage addition which would be required for full inspection to be carried out during all stages and for the tenderer to assume responsibility for all workmanship. Straight tendering on a specification which required the supplier to include inspection would tend to place an unscrupulous firm at a financial advantage if it planned to economise on subsequent inspection. An alternative which might avoid the undercutting of prices, and a method which had been employed in other fields, would be for the engineer to declare that, unless a particular economic advantage of method be demonstrated by the tenderer, the lowest tender would be rejected if it were more than, say, 5% lower than the next!

61. Consequent upon works application of protective coatings the problem of protection in transit often arose and Mr Arnold believed it necessary to take some care in specifying the nature of the protection required and in seeing that the work was carried out. Colleagues of Mr Arnold had experience of severe corrosive damage to zinc-sprayed steel bridge-members which had been stowed against brine or salt-packed cargo during shipment to West Africa. The ensuing work required on site to clean off and make good the damage was quite extensive. The cost of providing transit protection must be included in the initial quotation and suitable inspection provided when the contract was executed. Transit protection may include both protection to coatings against mechanical damage caused by abrasion and protection from contact with corrosive fluids. It would probably be necessary for the enquiry or invitation to give a lead on the type of protection required, though in this case it was inevitable that a balance between cost of protection, cost of insurance and cost of remedial site work be sought. This solution was best achieved by agreement between the site contractor and the manufacturer. Inspection to cover this phase of the work could again be covered by the manufacturer's organization.

62. Mr Arnold agreed with much of the Author's observations in § 39 but considered that ultimately confidence in the contractor's own inspection staff should be obtained such that the engineer's inspectors need only to carry out random checks from time to time. From the point of view of achieving maximum overall efficiency Mr Arnold would expect an integral inspection service to be set up within the manufacturer's own organization in order to provide the customer with work of the standard he required or specified. At the same time first class supervision and inspection could be carried out with a minimum disruption of workshop production. One should be able to expect a quality of application which would give the best performance that could be expected from the treatment specified. This was the sort of standard laymen expected from consumer goods bought retail, where, so far as was known, a reputable manufacturer provided his own inspection in order to achieve a standard which would retain his good will and help to assure sales of his product in a competitive field. Such quality control

could readily be applied to engineering construction and application of protective coatings and even to the application of a particular specification not normal to the manufacturer involved. It generally happened that tenders for supply and fabrication of structural steelwork, as a particular example, include the application of protective coatings and consequently comprehensive inspection of all stages could be carried out conveniently by the manufacturer. Much of the routine inspection of work, other than the application of specialized protective coatings, could probably be carried out by foremen, and through the widespread provision of inspection throughout a firm all employees in the firm would become more inspection conscious, to the ultimate benefit of the firm's reputation.

63. Manufacturer's requirements for application of protective coatings conforming to a general specification would probably differ one from another. Examples could be found in the application of wash primers, pretreatment requirements, curing times between coats and in the numbers of coats to provide a given thickness. Unless one firm was nominated to supply the materials, it was suggested that the proper body to exercise control and inspection was the contractor or fabricator who should be in the best position to integrate his work and inspection arrangements. Adherence to the manufacturer's specification for application of the products would then be obtained in accordance with a pre-arranged programme and without any sense of frustration developing while awaiting visits from an outside inspector.

64. In the Author's conclusion reference was made to a choice of that treatment which results in lower initial cost. Mr Arnold suggested that often the engineer had to accept a cheaper initial cost because the client preferred to pay for maintenance out of income rather than pay for initial protection out of capital already stretched to the limit. After all, the engineer stood to gain in his reputation by obtaining the client's agreement for a first class installation to be provided, albeit at a higher capital expenditure.

Mr W. H. Webb (Engineer, Braithwaite & Co. Structural Ltd) wrote drawing attention to the difference to the engineer in the cost of inspection of grit-blasting in an automatic machine compared with inspecting the work when it was carried out by hand.

66. Inspection of work grit-blasted in an automatic process was best carried out by ensuring that the machine was working with the correct grit, the correct velocities, the correct time of blasting etc. Periodic visits by the inspector should be sufficient to check the proper working of the machine and spraying and priming could generally follow immediately on grit blasting in his absence.

67. In the case of hand-blasting, given a certain air pressure, size of nozzle and other controllable factors, there was a specific rate at which areas of steel could be blasted and it was necessary to ensure that blasters spent adequate time on each part immediately before the primer was applied. Thus the inspector would probably have to be resident to ensure good preparation of steelwork blasted by hand.

Mr F. C. Porter (Metallurgist, Aluminium Development Association) commented that the Author referred to the use of pre-treatment (etch) primers and was rightly cautious, emphasizing the need for correct mixing and application to give effective results, noting that the acid content of the mixture used on steel and galvanizing was too high for zinc sprayed coatings. With aluminium-sprayed steel excellent adhesion was obtained without the use of such pretreatment but it would be interesting to know of any case-histories where modified or unmodified pre-treatment primers had been tried on aluminium-sprayed coatings.

69. Further data relating to painting of sprayed metal coatings would be valuable although it was appreciated that relative durability data might be limited in amount because of the extremely long life of most composite coatings of this type. For the same reason, Mr Porter presumed the Author did not remark on the ease of repainting such surfaces: very little re-preparation of the surface was needed.

The Author wrote in reply that he was very gratified that the Paper had received the attention of experts of long experience and that they had been sufficiently interested to comment. It seemed that all agreed that good inspection was necessary but there was some divergence of opinion as to where the responsibility lay.

71. He was completely in agreement with Mr Bennett that inspection control must be independent of production and, as stressed by Mr Arnold, it was important that inspection fitted with production schedules, failing to do so only if the work was found to be sub-standard. On the other hand the excuse that production was hindered by inspection was often the reason for lack of supervision. Mr Bennett was a little too critical of thickness testers. Those available were not ideal but with frequent calibration by the intelligent and trained inspector they gave good results. Like all scientific instruments they did not like rough treatment. A device for measuring roughness was receiving a good deal of attention and might be available before long.

72. Mr Carr seemed to suggest that the invitations to tender were sent out to firms selected with some care, hence the lowest tender could be accepted. This might well be the Engineer's wish but often, perhaps through the intervention of the customer seeking lower capital costs, tenders were obtained from quite inexperienced sources. The Author agreed that the type of inspection should be specified and maintained. The specification must be realistic and carefully drawn; such phrases as 'all scale to be removed by wire brushing' should be avoided, as it was quite impossible to remove adherent scale by this method. If the Engineer specified correctly the Contractor would have a direct responsibility to maintain the standard.

73. Mr Stanbridge was correct in stating that 100% inspection was impossible and unnecessary. The inspector must be well briefed and understand the probable points of weakness. With regard to the leaching out of soluble chromates, this should be very slow if the correct type of pigment was selected. It seemed hardly likely that serious damage could result from a few weeks of inclement weather. It was true however that there were several types of chromate pigment.

74. Mr Arnold's method of a preliminary inspection of the Contractor's facilities was excellent but even so the Engineer must, by frequent unheralded visits, encourage the use of those facilities. It was true that some suppliers made frequent visits to see that their materials were being used properly and this tendency should be encouraged. The damage to protective schemes in transit was important and inspection at both ends seemed to be the only solution.

75. Possibly the best method of ensuring adequate inspection was for tenders to be invited in two sections (1) for the work, so that direct comparison of price was possible, and (2) an extra for inspection in accordance with specification.

76. The Author agreed with Mr Webb that it was much easier to assess blasting from a mechanized plant. In the case of hand blasting, inspection by the Contractor all the time was necessary.

77. Mr Porter rightly emphasized that sprayed aluminium did not need an etch primer as the metal did not yield the voluminous white rust common with zinc. It was not known whether any large aluminium-sprayed jobs had been treated with such a wash but it would not be deleterious or useful. Mr Porter was to be thanked again for stressing the long life of a correctly-applied composite system and the ease of repainting when failure ultimately starts.