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United Nations Industrial Development Organization

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
1000 L'AMSTERDAM AVENUE
NEW YORK, N.Y. 10017
TELEPHONE: 917-500-1500

Director General
United Nations Industrial Development Organization
1000 L'AMSTERDAM AVENUE
NEW YORK, N.Y. 10017

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
1000 L'AMSTERDAM AVENUE
NEW YORK, N.Y. 10017
TELEPHONE: 917-500-1500

P. S. S. S.
Assistant Director (Industrial
Development Organization and
United Nations Regional Commissions for Asia
and the Pacific, India)

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I. INTRODUCTION

1. Among the developing countries in the ECARE region, India holds a prominent position in the production of plastics raw materials and their conversion into a range of consumer, industrial and building products. According to 1970 production of 105,000 tonnes, India held 23rd position among plastics producing countries in the world. Plastics industry in India has been growing at a much faster rate than either industrial production generally or chemicals and chemical products. The production of plastics during the 60's rose impressively at compound annual growth rate of 28.7 %. The total investment in the plastics industry rose from Rs. 250 million to over Rs.1000 million in 1969. The production of plastics raw materials recorded a phenomenal increase during the 60's from less than 13,000 tonnes in 1961 to over 100,000 tonnes in 1970. By value the output rose by 700 % . Processed goods comprised 60 per cent of the total exports of plastics. India's share amongst the Asian developed countries touched as high as 35 % in resin production, and 70 % of plastics products are exported to Asian and African countries.

2. Packaging, consumer and industrial products are the major applications of plastics . Building industry comes next as the potential consumer of plastics.

II. TRENDS IN PRODUCTION

Plastics raw materials

3. The Indian plastics industry got its start in the Fifties, and in the early Sixties organized itself systematically, when small capacity PVC, polystyrene, and polyethylene plants were established. During the latter-half of Sixties, naphtha cracker units were established , and petroleum

ethylene became available. Recently, all the high quality plastic materials are produced indigenously. Commencing with the plastic petrochemicals-based plastics industry, future demand for plastic has been worked out. There are ten units engaged in the production of thermoplastics, two each in PS, and LD PE, one in HD PE, and five in PVC resin. Thermoplastic production accounted for 106,600 tonnes out of the total plastic raw materials production of 122,554 tonnes during 1972. The consumption of plastic during the same period was around 135,000 tonnes.

4. With the increased demand for plastics by 1975 and 1980, the existing manufacturing units are in the process of expanding their capacities, besides setting up of Royal Petrochemical Complex in Faridkot (Punjab State) which has been planned to establish manufacturing capacities (both in private and public sectors) of about 140,000 tonnes of LD PE, PE, PP and copolymers, Nylon chips, and polymethylmethacrylate by 1975. The production of plastic raw materials during 1970-72 and the estimated demand by 1975 and 1980 are indicated in Table 1.

Processing machinery

5. Considerable progress has been made in the indigenous manufacture of processing machinery and equipment. Already standard type injection moulding machines upto 1.4 kg capacity, and extruders upto 112 mm capacity are available in the country. Manufacture of standard type blow moulding machines has been undertaken.

6. In regard to calendars, automatic spreading machines, embossing and printing rollers, large capacity injection moulding machines and extruders, coating machines, and several other specialised equipment, the industry has to rely on imports. It will not be economical to produce the entire

range of plastic processing machinery locally in view of the low demand for such equipment.

7. Much hooding has been made in the manufacture of moulds and dies within the country. An Institute of Plastics Engineering and Tools was established in Madras in 1956 with UN assistance, and it has been playing useful role in training personnel in mould design and mould making.

III. GROWTH IN BUILDING APPLICATIONS

6. The expanding house-building activities during the Five-Year Plans have prompted the expansion of building materials industry in India. The production costs of major traditional materials like the bricks, cement, steel, non-ferrous metals and timber have been going up, and invariably there have been in short supply to meet country's anticipated requirements. The necessity for development and introduction of substitute and new materials has been felt. With the expansion and diversification of plastics industry, and keeping in view the developments in the field in advanced countries, the Indian building industry looked to plastics as potential building materials source. The production and estimates for availability and expected requirements of major materials including plastics for the construction industry in India by 1974-75 and 1980 are given in Table II.

9. Since plastics were relatively new materials for the building industry the need to bridge the communications gap between the manufacturers and the users, as to the technical advantages, limitations, and economics of use of these materials was realized. A range of building products using plastics in various forms is currently being produced and marketed in India, and these are listed in the Annex.

Role of National building organisation (NBO)

10. Systematic promotional, developmental work in introducing plastics in the building industry was initiated by the National Buildings Organisation in the Ministry of Works & Housing, Government of India, in 1966. This was necessitated with a view to supplementing the shortage of traditional materials in certain applications where plastics offered economy and better service performance. The work was undertaken through organising frequent seminars/meetings/get-togethers, and publication of technical reports/notes/papers on various aspects of the use of plastics in building. The first Seminar on Plastics in Building and the Plastics Development House was organised in 1967. This was followed up with the constitution of a Committee for Promotion of Plastics in Building. The Committee has since met thrice (1966, 1969 and 1972) and considered and approved of several proposals for promoting and coordinating building applications in plastics. To bring home to the engineers, architects, and plumbers the advantages, limitations and economic use to demonstrate the proper selection and installation of plastics sites under local conditions, a series of five get-togethers cum demonstrations, and four training courses had been organised in different regions of the country during the period 1968-72. A Technical Conference 'Why use plastics in the Indian building industry' which was largely participated by the building industry and plastics manufacturers, was arranged in New Delhi in October 1972. A training programme on 'Use & Maintenance of Plastics in building' is being planned for the benefit of senior level engineers and architects drawn from major construction agencies, during the last quarter of 1973.

11. The NBO maintains a Plastic Establishment providing a consultation service for the

architects, engineers and builders, and would-be-entrepreneurs who would like to manufacture new plastics building products, keeps liaison between the manufacturers and the users from various construction agencies, and maintains contacts on the subject with research and development organisations in different countries. More than thirty technical papers/notes/reports on the subject have been published. Periodic Supplements under the titles 'Plastics in Building' and 'Building with Plastics' appear in NBO Journal, and Popular Plastics journal, and these are contributed by NBO.

12. At the recommendation of the Committee for Promotion of Plastics in Building, the formulation of Syllabus of course of lectures/practicals on plastics as new building materials, has been taken up, for introduction in the Schools of Architecture in the country.

13. The NBO is the only organisation in India responsible for assessing, evaluating and recommending building applications in plastics, and relevant technical enquiries from the manufacturers and the users are referred to NBO.

IV. PROBLEMS

User requirements and user habits

14. India is a tropical country, the hot and humid climate which varies from region to region, demanded careful examination and study of user requirements and habits for adoption of plastics in building applications. Plastics are basically 'delicate' materials to handle, their storage, and installation on construction site called for reorientation of the local user habits, and training of workmen in the trade. Plastics piping system for cold water services is an important application being adopted widely by the building industry. At the initial stages, their improper installation had posed several problems leading to outright rejection of the use of these new materials. To have an assessment of various performance problems encountered

under different situations, the B.R. has undertaken the work of collection and compilation of case-histories on the use of plastic pipes in the country. A Guide to the installation of plastic pipes keeping in view the local requirements and habits in the building industry has been compiled for the benefit of engineers and plumbers.

15. The earliest experience of the use of low-density PE pipes for rural water supply schemes had posed problems in outdoor installation, such as frequent damage by 'rodents' and miscreants. The use of UPVC pipes was introduced in 1962-- imported from Holland and installed by Municipal Corporation Delhi for rural water supply scheme, altogether 1000 metres of UPVC pipes in sizes from 50 to 125 mm were used, under the guidance of a representative of the Dutch firm, and with the assistance of local labour. To date these UPVC pipes have performed satisfactorily under local conditions.

Research and Development

16. No systematic research and development work relating to the introduction of, and in-field performance of plastics as new building materials had been undertaken until recently. Lately the following research problems have been identified :

- (i) designing suitable sandwich panel using plastics foams as core materials, for use as partitions, curtain walls, and in putting up warehouses, and Emergency structures;
- (ii) Standardising the weathering characteristics of plastic materials under Indian climatic conditions;
- (iii) designing suitable jointing and installation techniques for UPVC piping systems in particular for internal plumbing; and
- (iv) utilizing industrial wastes like fly-ash, stone-dust, wood-flour etc as fillers in conjunction with plastic materials such as polyester, and PVC to obtain composites suitable for moulding building components like cladding panels, doors, and window frames.

... of plastics in building, the ... (if ...) ... in operation with the plastic ...

Quality Evaluation

1/. Evaluation of satisfactory service performance of plastic products under local conditions is an important aspect of study. This would facilitate organized growth and judicious use of plastics in building. The NBO has been recommending and specifying plastic products in 'experimental projects' to evaluate the service performance. The products under view are, plastic piping systems, building hardware, overhead water storage tanks, flushing fixtures, doors, and window-frames. The need for an independent body like 'Technical Approval Board' (operating in Europe) which should be responsible for technical assessment of new building products including plastics, has been felt.

Quality Control and Standardisation

2/. Experience in the manufacture and use of plastic building products under local conditions is gradually being built up. It is not an accepted practice to specify raw materials unless these are made and certified as per relevant standard specifications. The diversification and the introduction of plastics building products has necessitated the formulation of Indian standard specifications. Local building industry requirements coupled with the experience gathered in the field from advanced countries are taken care of while writing specifications. The building industry is encouraged to use only those plastic products which are certified by 'ISI' Mark of quality. Lately there has been a thinking in the building industry of introducing performance specifications for plastic products.

V. ACHIEVEMENTS

1. Building Industry

The Building Industry in India consumed over 25,000 tons of various plastics in building applications during 1972. This constituted about 1/3 of the total consumption of plastics (including and around 2% in value of total expenditure incurred on building materials during the same period. Application-wise consumption of plastics in building in India is indicated in Table III.

Piping systems in plastics (UPVC) have made a viable impact on the building industry as their adoption for cold water services, against the conventional pipes, has effected a fair amount of economy in water supply schemes. Presently the installation of UPVC pipes produced and marketed (T.I.V.) in India, is economical as against A.C. pipes in smaller sizes upto 125 mm diameter about 15%, and by around 100% against Cast-Iron and B.I. pipes in all sizes. Increased demand on the use of UPVC pipes has been placed with the fact that 1972 production of 8,000 tonnes could not meet the requirements required by various user departments. In addition to the existing four units, a dozen new manufacturing units are being established to produce UPVC pipes. Currently these pipes are produced upto 315 mm size as per Indian standard specifications.

Plastic fittings in particular like the use of common water tap in polyethylene, and building hardware items like handrails in PVC, and window sills in EP, have found wide acceptance with the construction agencies. These applications have been prompted to conserve the use of non-ferrous metals, and avoid 'thefts' commonly met with for brass-fittings in public buildings. At the Third Asian International Trade Fair, held in New Delhi (1972) a number of structures of the Pavilion Fair used plastics in some form or the other. Among the products included, 30,000 sq. metres of HD PE woven fabric,

15,000 sq.metros of PVC-reinforced floor tiles, 7 tonnes of polyester resins, and 4,500 metres of UPVC pipes, and 1,000 metres of PVC handrails.

11.4.2.2.

23. The emphasis on the use of plastics in the Indian building industry is to conserve costly and scarce traditional materials. In addition to the range of building products (ref. Annex) which are fairly well accepted, the suitability of the following products which have bearing on reducing the cost of construction, is being investigated:

- (i) Overhead water storage tanks in polyethylene as replacements to conventional RGS and MS tanks; and
- (ii) Utilizing wood-fibre filled PVC extruded profiles, and wood-plastic composites for designing door-, and window-frames, replacing the conventional timber, and lately introduced steel frames in residential buildings.

24. The introduction of these products will help conserve the use of cement, steel and timber. The production of UPVC pipes is being diversified to include pipes for soil, and water, and underground drainage systems. The preferential use of plastic, and more appropriately as composite materials have good prospects to meet frequent shortages of traditional materials in India. The consumption of plastics in the building industry is expected to range between 20 to 25 % of the total plastic production in India during the period 1975-80 as indicated in Table V.

VII. CONCLUSION

25. The systematic development and gradual introduction of buildings applications in plastics have found ready acceptance with the Indian building industry. There are still a number of problems and inhibitions in regard to introducing plastics in certain building applications. Both the research and development organisations and plastic manufacturers are

appreciative of the local industry and government. Technical evaluation of plastics building products and the performance specifications for these new materials are an important aspect of the subject which is yet to be organised in India. With the increased production and diversification of plastics industry, and the necessity to meet the growing demand for building materials, the use of plastics would certainly play an important role in the Indian building industry.

VIII. AREAS OF UN ASSISTANCE

26. UN assistance to organise the following activities in the field of plastics would be welcome:

- (i) Performance evaluation of plastics as new building materials: Performance study of these materials under local conditions of hot and humid climate, setting up of 'Agreement Board' and formulating performance specifications based on the experience in advanced countries;
- (ii) International Symposium: To revive the 1971 proposal of organising the Symposium in India, for the benefit of developing countries, to review and discuss various aspects of use of plastics in the building industry; and
- (iii) Plastics Exhibitions: To offer preliminary technical assistance and patronage for organising International Plastics Exhibitions under the banner 'ASIAPLAST' in India, with a view to promoting regional trade and transfer of technical know-how in the field of plastics among developing countries.

ANNEX

List of plastics building products currently being produced and marketed in India

- (i) Surface coatings-paints & varnishes ;
- (ii) Resin-bonded wood panels ;
- (iii) A range of electrical fittings and lighting fixtures ;
in phenol-, and urea-formaldehyde, polystyrene, and
acrylics;
- (iv) Electrical conduits in PVC and PE ;
- (v) Pipes and fittings in UPVC and PE, including taps,
showers, basin, and sink-wastes, waste-trap, floats
and syphons in polyethylene;
- (vi) Decorative laminates for surfacing wooden furniture ;
and panelling ;
- (vii) PVC floor tiles (PVC-asbestos) ;
- (viii) PVC coated wall paper, PS wall panelling, PS wall tiles;
- (ix) PVC hand-rails, curtain-rails, staircase nosings;
- (x) Epoxy-resin floor toppings for industrial floors;
- (xi) Rooflight sheets in glass-fibre reinforced polyester
resin (GRP);
- (xii) Glazing and partition panels in GRP;
- (xiii) Polyethylene film for water-proofing and damp-proof
course;
- (xiv) Bath-tubs in GRP;
- (xv) Flushing cisterns in high-impact polystyrene;
- (xvi) Thermal and sound insulation material- expanded PS;
- (xvii) Concrete formers in GRP;
- (xviii) Water-stops (water-bars) in PVC;
- (xix) Chairs in GRP and polypropylene;
- (xx) False-ceiling panels in GRP, high-impact and expanded PS;
- (xxi) Window fasteners and stays in polypropylene;
- (xxii) WC seats in urea-, phenol-formaldehyde, PS;
- (xxiii) PVC leather cloth (including foam-PVC) .

Table I Production of Plastics Raw Materials and Estimated Demand in India by 1975 & 1980

(in Tonnes)

Material	1970	1971	1972	Estimated Demand	
				1975	1980
Styrene	5,300	5,500	5,000	6,500	9,000
Styrene Mldg powder	1,050	2,000	2,000	4,500	9,000
Polystyrene	9,300	11,000	12,600	35,000	40 to 70,000
Polyethylene					
HD :	23,000	27,500	23,000	60,000	165 to 190,000
LD :	18,350	24,000	20,000	30,000	40 to 50,000
Acrylonitrile	38,750	42,500	46,000	80,000	145 to 175,000
Cellulose	1,050	1,500	1,500	5,500	7,000
Methyl Methacrylate	N.A.	N.A.	N.A.	13,000	22,000
Acrylonitrile	4,500	5,400	6,000 ¹	12,000	24,000
Cyanoacrylate	354	405	1,000 [*]	1,400	3,200
Polymethyl Methacrylate	270	380	454	750	N.A.
Polypropylene	-	-	-	7,000	25 to 50,000
Phenolic Resin	-	-	-	5,000	10,000
Total:	101,924	120,185	122,554	260,650	530,200 to 613,200

* Production figures not available.

¹ Revised production figures including manufacture in small scale sector.

Table II Production and Estimates for availability and expected requirements of major materials including Plastics in India, for the construction industry

Material	Prodn.in 1972	Estimated Prodn.in 1974-75	Availability for construction in 1974-75	Expected requirements in 1980
Bricks (mill.Nos)	20,000	24,000	24,000	37,500
Cement (mill. tonnes)	14,93	18.0	17.0	27.0
Steel (mill. tonnes)	6.9	7.2	4.0	6.00
Timber (mill. Cu.metre)	-	2.0	2.0	4.0
PLASTICS	122,554	260,650	67,500	131,000

NOTE: Consumption of plastics in building applications during 1972, was 25,500 tonnes.
Production of plastics raw materials by 1980 is expected to be around 600,000 tonnes.

Table III Application-wise consumption of
Plastics in Building in India
during 1972

(in tonnes)

Application	Material	Consumption
Pipes & fittings (including electrical conduits)	PVC PE	8,000 1,000
Resin-bonded wood panels	UF/PE resins	6,000
Electrical fittings & lighting fixtures	UF/PE/PVC/PS/ Acrylics	5,000
Decorative laminates	PE/melamine resins	2,000
Floor & wall coverings	PVC	1,000
Sanitary fittings	PE	5,000
GFR Products	Polyester resins	500
Insulation	PS foam	500
Miscellaneous	PVC/PE/PP	1,000
	Total:	25,500

Table IV Comparative costs of laying and jointing of
UPVC pipes against CI and AC pipes in India

(in Rupees)
per metre

Dia mm (inside)	CI pipes Class LA & B with tyton joints	CI pipes with lead caulking joints	Asbestos cement pressuer pipes Class III	Dia mm (outside)	UPVC pipes (kg/cu sq.)
1	2	3	4	5	6
90	22.97	23.70	13.42	90	10.97
100	23.48	29.92	16.43	110	14.57
125	36.14	38.25	20.72	125	16.77
150	45.54	47.97	26.58	140	25.80
200	64.95	68.23	41.76	160	32.50
250	97.62	111.06	52.60	180	36.00
300	123.52	122.58	61.95	200	47.00

Source: M L Anand Suptdg Engr Municipal Corporation Delhi.

Table V Estimated Annual consumption of plastics for building applications in India
by 1975 and 1980

Applications	Plastics materials	Estimated consumption	
		1975	1980
Pipes & fittings (cold water services, soil-, rainwater systems, underground drainage, electrical conduit etc.)	PVC	40,000	75,000
Flushing cisterns	HI HD PP	Nil	1,500
Overhead water-storage Tanks	PS	10,000	15,000
Door-, window-frames & shutters	PVC structural PS foam	1,000	1,500
		1,000	1,500
Building hardware	PVC/PS/ABS/PP/Nylon	500	1,500
Miscellaneous: (adhesives for wood industry, decorative laminates, GRP products, electrical fittings, lighting fixtures, floor & wall coverings, sanitary fittings, insulation etc.)	PP/DE/Malamine/ Polyester & epoxy resins PE, PS, PVC etc.	25,000	35,000
Total :		57,000	131,000

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5. Ratra O. P. - 'Plastics in building' - Start of development over traditional techniques. Financial Express (Bombay) Sept. 30, 1952.
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Explanatory Notes on Exhibits

- Fig. 10. 100 10 galvanized the ease of handling and
distribution of PVC pipes for cold water
distribution lines, by the local labour.
- Fig. 11. A display of sanitary fittings and building
hardware items produced in India.
- Fig. 12. Polystyrene wall tiles used against kitchen
counter top.
- Fig. 13. Polystyrene wall paneling in attractive design.
(Reinforced)
- Fig. 14. Use of HD PE woven fabric as cover for Exhibition
area.
- Fig. 15. Use of HD PE woven fabric in one of the pavilions
at the 1964 Fair.
- Fig. 16. Another view of the pavilion in Fig. 15.
- Fig. 17. The roofing material used in one pavilion at the
1964 Fair.

FIGURES



1



2



3



4



5



6



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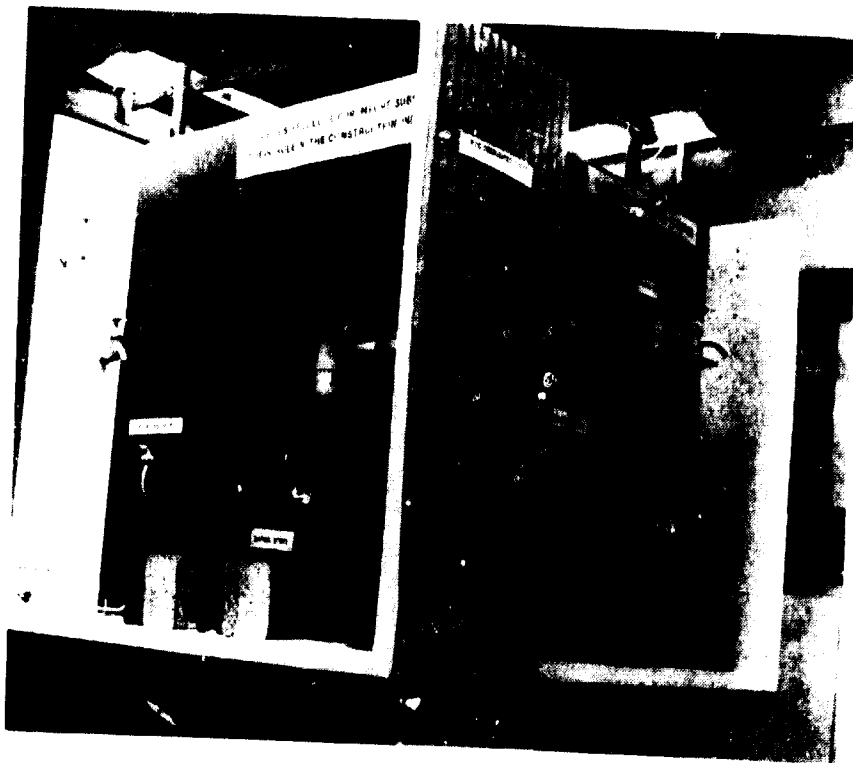
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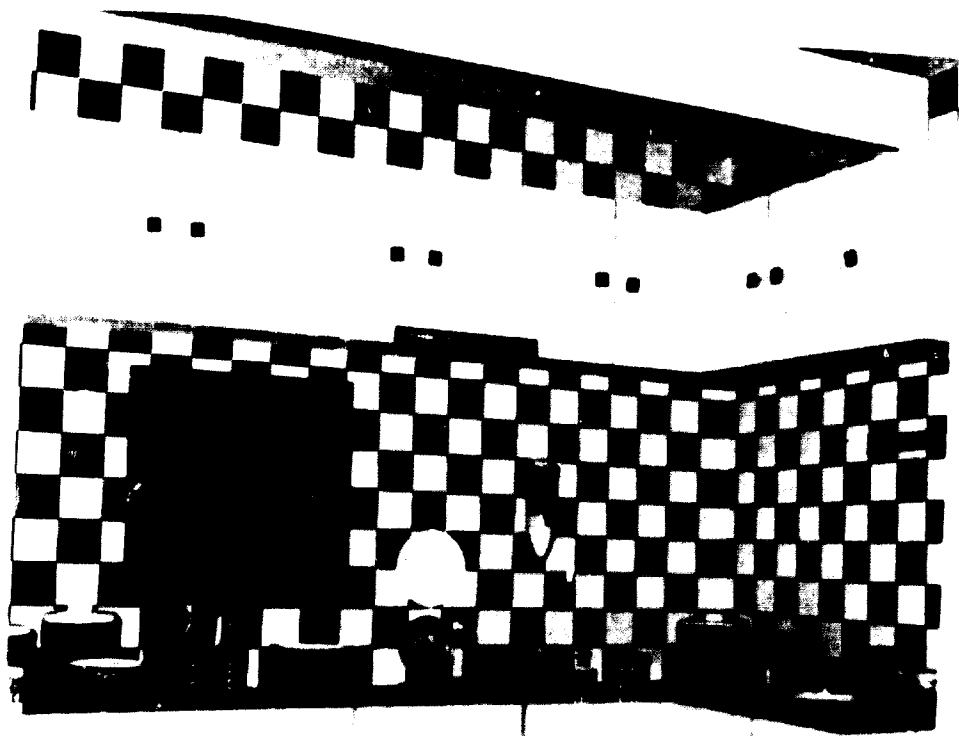
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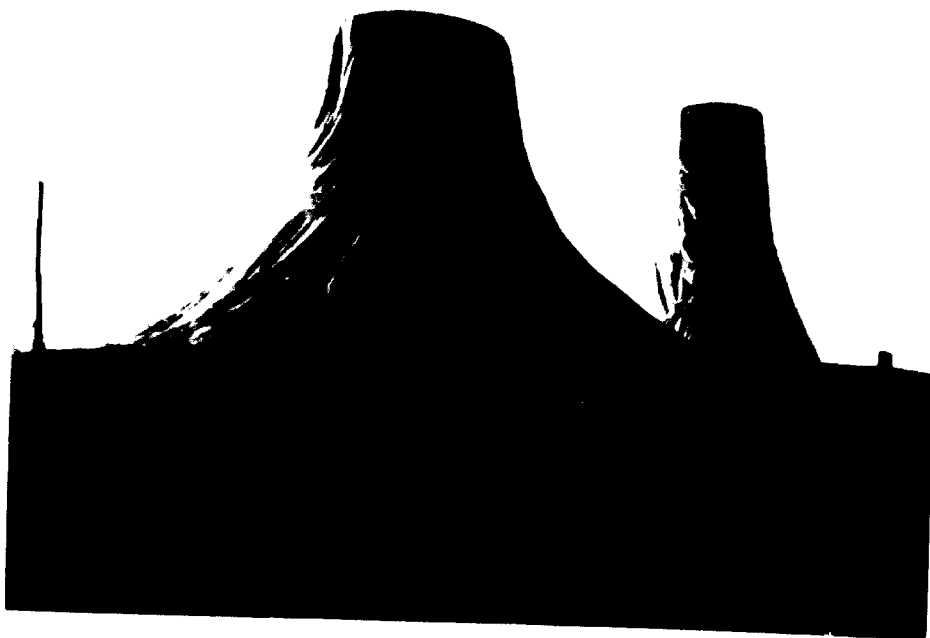
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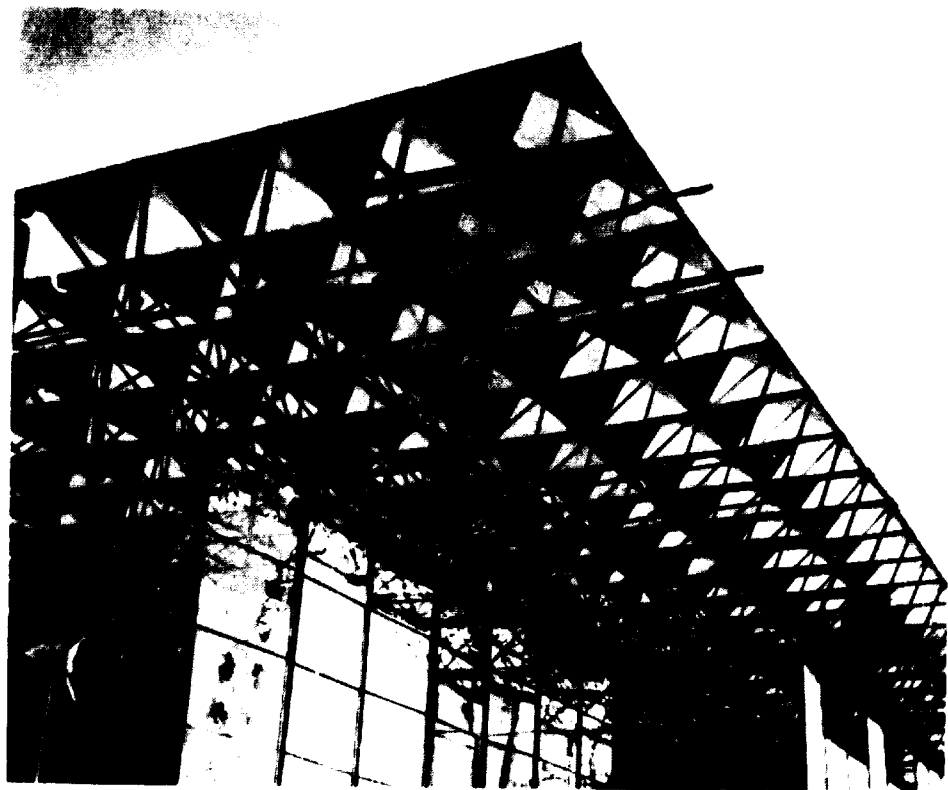
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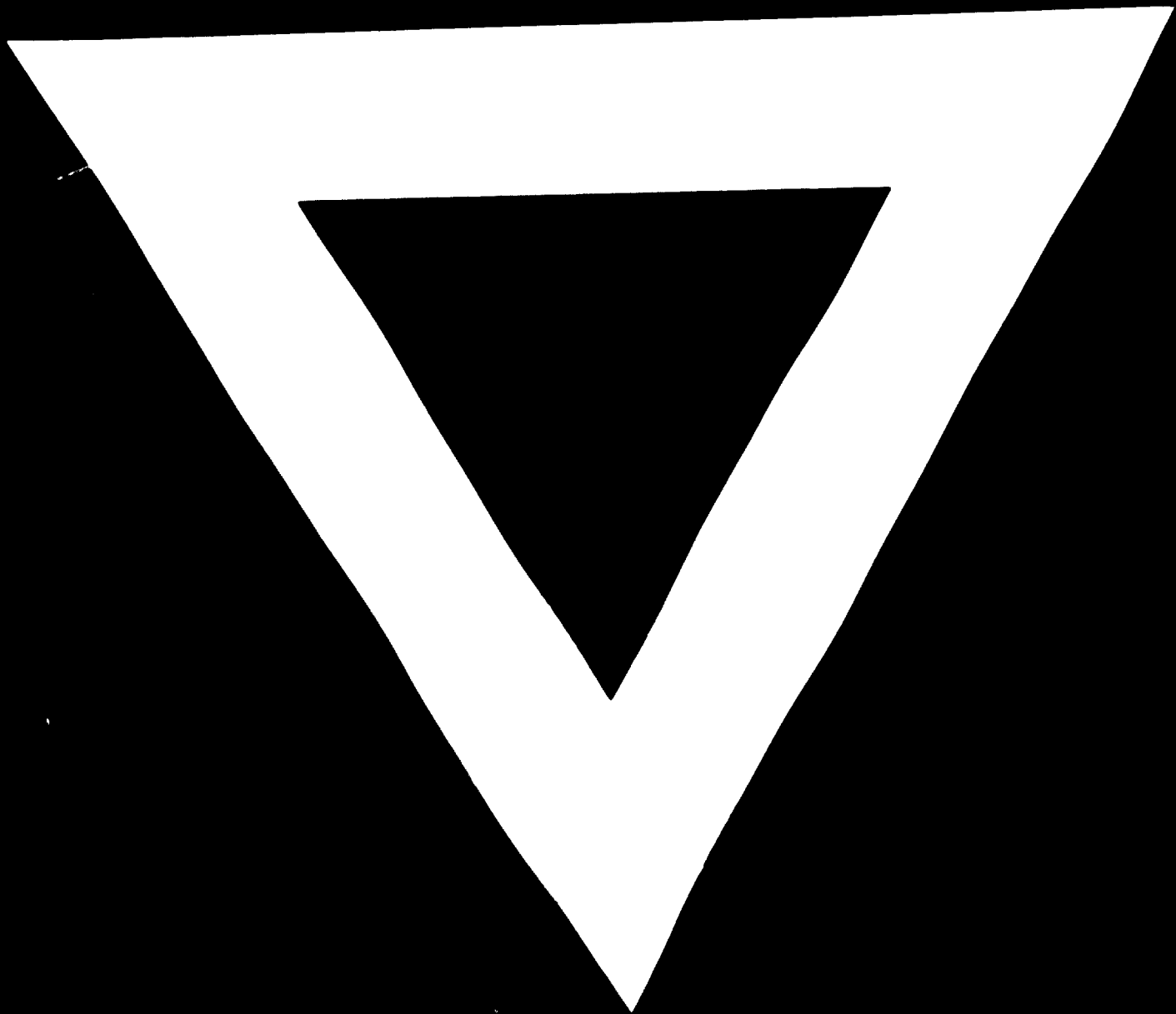


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