Kauṭilya's Arthaśāstra in the Light of Civil Engineering and Architecture

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Abstract

In this article entitled *'Kauṭilya's Arthaśāstra* in the light of Engineering and Architecture' we have tried to forecast on Kauṭilya's thinking in the light of Engineering and Architecture of modern science. The *Kauṭilya's Arthaśāstra* as the name indicates is a treatise on *Arthaśāstra*. A definition of this śāstra is founding the concluding section of the work. There are many indications in the text that it has in view a comparatively small sized state. Similarly the book refers to 'Janapada's Or 'vāstuka'. From these references vāstuvidyā or Engineering science has been choosen as topic of discussion. Janapada the territory with people settled on it, durga the fortified capital etc. play an important part in the administrative system.Arthaśāstra considered as a manual of statecraft and administration contains within it a wide spectrum of technological details by way of infrastructural adjunct to the various spheres of administration. The author injecting contentment and sense of security in the overall social fabric, would conceive that a strong superstructure can be built only on strong infrastructure. Various branches of Civil Engineering, as we understand today that technology, like town and country planning lay out plans for buildings architecture, design, construction materials, sanitation, irrigation etc. are to be found occupying appropriate place in the *Arthaśāstra*. In *Arthaśāstra* the sūtras, which are related to vāstuvidyā that is to the more comprehensive technology of Civil Engineering of today have been discussed in this article. Town planning architecture and civil Engineering, soil Mechanic

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foundation, Buildings and Towers, Royal place-all these have been focused here in brief we have followed R.P. Kangle's edt. in case of references.

Objectives

Now-a-days we build Apartments, high rising buildings, our residences with a plan or drawing by the Engineers and Architects still those buildings collapse, ruined out. But we are astonished to see in the Arthaśātra well developed structure planning. Elements of Civil Engineering are

i.Town and country planning ii.Lay out of Buildingsiii.Design aspects including foundation, excavation, stability of excavated slopes, construction materials.iv.Irrigation engineering including hydrology and hydrometeorology.

The essence of such planning can be classed as:

(a) The settlements might either be renovation of earlier settlements or a new one.

(b) The settlements should have well defined boundaries either in the form of natural physical entities like river, mountain, forests or could be built up, like embankments or planted tress.

(c) The settlements to have people of learning and those in different professions to be favoured with land.

   If these structure rules are followed a town becomes well-planned. These objectives instructed in the Arthaśātra are for the strong construction of a building and indicates planning for beautification of a town.

Town planning, Civil and Architectural Engineering

Arthaśāstra, considered as a manual of statecraft and administration contains within it a wide spectrum of technological details, by way of infrastructural adjunct to the various spheres of administration articulated towards the stability of the kingdom, the prosperity and protection of the king and his

subjects. Means and measures of abating any external social fabric, would conceive that a strong superstructure can be built only on strong infrastracture. And the latter comprises the suitable dwelling place such as buildings, roads communication means of production, protective measures and so on. Various branches of Civil Engineering as we understand today that technology, like town and country planning, lay out plans for buildings architecture, design, construction materials, sanitation, irrigation etc. are to be found occupying appropriate place in *Arthaśāstra*.

In the *Arthaśāstra*, the sutras, which are related to vāstuvidyā that is to the more comprehensive technology of Civil Engineering of today in dealing with the subjects enumerated briefly in *Kautilyas Arthaśāstra*.

The definition and evolution of vāstuvidyā are relevant in the discussion of the version branches dealt with in *Arthaśāstra*.

> Vāstuvidyā was a branch of more comprehensive Śilpaśāstra but gradually with in the time the two become identical. Vāstuvidyā means the science dealing with vāstu. The word vāstu occurs in the Ṛgveda in the sense of the building site or the science of Architecture. Later on however various other subjects connected to it were incorporated in it. Thus, vāstu, a place where man dwells includes not only a place where man dwells includes not only building site and prāsāda or temples and places but also conveyances. The śilpaśāstra which included the vāstuvidyā is defined in Śukraniti as a science dealing with public works such as temples, images of gods, gardens, house and tanks. (*Bhattacharya,* 1994)

Public works including sanitation, roads, irrigation are now considered within the domain of Civil Engineering and these are the subjects and branches which find place is extensive discourse in *Arthaśāstra*.

Town Planning

The manner in which the towns are to be laid out has been outlined in details (Book 2 Chapter 4) as under: The site selected on the basis of suitability for accommodating reports of four

castes for laying the town is to be divided into various sectors by 48 ft (8 daṇḍa) wide royal highways: three in each direction should traverse the area from east to west and north to south. The twelve terminal ends of the roads at the boundaries, should have gates at each locations provided with appropriate arrangements for drainage way and canopied passage. The widths of other types of roads, like paths for irrigation work, path for elephants, cattle paths etc. and those running through different types of towns have been specified according to their purpose importance and service ability.

The township is to have the royal place at the center and inhabitants belonging to four castes should have their respective locations. Different sectors are to be allotted for people of various professional merchants, traders, market places for different commodities, places for worship, army quarters, physician's etc. All forms of conceivable infrastructural support systems for civil, military, trade and industries have been assigned suitable locations within the township.

It is amazing to note how meticulously every aspects of social life have been considered or arrangement in locality. These aspects of the town planning, consulted in a few satraps form a subject of independent study. How such schemes conform to reality can be visualized from archaeological evidences available so far.

A number of cities located with the Gangetic province and peripheral areas have archaeologically been identified and according to the areas enclosed by the ramparkts, these cities can also be graded, Among the cities of this province are Rājagṛha (Rajgir) the earliest capital of Magadha, Kauśāmbī, Mathurā, Kapilāvastu, Śrāvastī etc. On the northern edge of the Gangetic plains, Balirājgarh, and Bāngarh in the north east, and Mahāsthāngarh (now in Bangladesh) in the east.

Cities surrounded by defensive walls, moats and ramparts are some of the typological characteristics which belong to Mauryan period and after. It is nearly true of almost all Gangetic cities.

> Perhaps a better criterions of classifying cities is in terms of their outline plans. We would expect from *Arthaśāstra*, a city to be square with three gates along each side, and roads dividing it into regular square block. In the standard *Arthaśāstra* city-there is a central square in the middle of the city, with the royal place on its north side. The square plan is nearly represented at Śiśupalgarh, where four ides make a near square and *Kauśāmbī* where there are sides suggestive of a regular rectangular plan, although it is irregular on the side founded by the Yamuna river. (*Alchin*, 1995: 204-9)

The concept and plan of cities, as described in the *Arthaśāstra*, have been brilliantly illustrated by *Rangarajan* (*Rangarajan,* 1992:)

Municipal ordinances to be enforced by the city superintendent and his staff have been recorded in minute details, with the severity of punishment to be meted out to violators of such ordinance. Sanitation, hygiene, physical environment and all necessary for sustenance of healthy life have been dealt with. And these reveal the mindset of the composer. The dwelling place has not been conceived as a physical entity only-but an expression of a mind-conscious about the complexities and intricacies of interaction between man and nature and social role of man. Town planning in the context of human civilization perhaps exhibits the organized mind-in the evolutionary stage of civilization.

And the organized mind is very well demonstrated in the *Arthaśāsta* the way the layout of a town has been planned. During the monarchial system time the entire administrative activity was directed to the service of the king whose motto was to be the overall welfare of his subjects, because on that depends the happiness of the king. The king had to offer adequate protection to his subjects, provide opportunities for trade and business, encourage learning, support productive endeavors, etc.

All these are to manifest the way space was to be demarcated some-wise for each type of activity.

Enormous importance is given to the form of a city. It is said that cities are product of time that 'the city records the attitude of a culture and epoch to the fundamental facts of its existence that.

> It represents the maximum possibility of humanizing the natural environment and of naturalizing the human heritage, it gives a cultural shape to the first, and it externalizes, in permanent collective forms, the second. *(Lewis,* 1944:46*)*

It has further been stated that the city is a related collection of primary groups and purposive associations. The first like family and neighbour- hood, are common to all communities, while the second are especially characteristic of the city life. These varied groups support themselves through economic organizations that are likewise of a more or less corporate or at least.

That are likewise of a more or less corporate or at least publicly regulated character, and they are all housed in permanent structures, within a relatively limited area. The essential physical means of a city's existence are the fixed site, the durable shelter the permanent facilities for assembly, interchange and storage the essential social means are the social division of labour which serves not nearly the economic life but the cultural process. *(Lewis; 1944: 480)*

Modern analyses of the city structures, as these are glaringly represented in the town planning contained in the *Arthaśāstra*. As a matter of fact the latter seems to have been taken as the model in the characterization of a town interestingly this medieval period of history makes the advent of town planning in the then civilized centers of the western world. In Greece fourth century BC. was the period which assumed great importance in the history of architecture.

> The development of town planning and a greater variety of specifically designed civic buildings, are two features of the age. New towns, laid out to the regular plan associated with a regularly planned market-place surrounded by colonnades and meeting places for the assembly and council. Much greater attention was now paid to the amenities of life, well paved streets with efficient drainage became a normal feature of Greek towns. (Donald, 1965: 75)

Town planning prevalent in the ancient western world bears strong similarity with that described in the *Arthaśāstra*. Just like mullicentric evolution of organic world, cultural evolution can also be perceived to have originated simultaneous by in far and wide centers. In every stage of evolutions the noticeable factor, which took shape in every sphere of life, was the concept of order as the basic factor can still be found in the concept of modern town and cities. In that sense it may be said that in the concept of town planning, the most characteristics feature of the ancient forums has still been preserved today.

The three models amongst many others world over, associated with the Chicago school, are worth mentioning even as ideas pertaining to urban planning and growth these are in brief.

Concentric zonal growth model:

(a) In this a city is presented as a set of circles, each one ringing the small one within it At the center is the business district, outwardly spreading successively as the center of wholesale business industry, followed by a zone of transition

(b) Sector model: In this concept some cities row not in ever expanding circles, but in segments or sectors. often the growth pattern follows the topography of the land or most favoured transportation routes, whether rail, bus or truck.

(c) Multiple-nucli model: Certain kinds of land use are found in separate district areas. Industries are located near the transportation routes needed for shipments of raw materials and finished goods. In a harbor city for example industrial areas would be concentrated near the port. Similar uses of land cluster together because proximity helps them as in financial and shopping districts. Still other land users are motivated by the need of distance. (*Rose Glazer*, 1982: 365.)

The concepts of city as above brings out a strong similarity with *Kautilya's* concept of physical set up, specifically in the distribution of city slots according to the classes of occupation in segmented sectors and infrastructural supports for functional integration.

From the dawn of civilization, when community living was forged into human society, the nature of physical form of dwelling places became a dominant issue of man's intellectual occupation. Several factors influenced this form. Sheltered habitations with closed economic activities decided this, later on cultural activities became way of town life. Overcharged with the confronting and conflicting situations making a city far from the desirable habitation, the emerging philosophy of city planning is turning to nature and symbiotic relations of man and environment a concept which is so vividly exhibited in the town planning contain in the *Arthaśāstra*, Aristotle thought of cities an 'Man come together in cities in order to live. They remain together in cities, in order to live a good life', As it is in politics, so it is in city building and architectural and urban form.

> The Romans brought the idea of the city down from the imagination of the philosophers and rendered it in brick and marble. (Van Pelt, 1991: 46-47)

Cities and towns are the physical deconstruction of mental concepts and perceptions. In this sense Kauṭilya demonstrates the highest level of concept and perception as revealed in his planning of the city and town.

Architecture and Civil engineering:

All aspects connected with the practice of civil engineering and architecture of today, especially with the construction of buildings, towers, ground excavation meant either as a protective moat around township or canals etc. are to be found recorded in code of practice in various sutras of *Arthaśāstra*.

These sutras are scattered in chapters 20 of Book 1, Chapters 3,4 and 5 of Book 2, Chapter 8 of Book 3.

As for the dwellings it starts from the selection of site suitably for constructing building, location of sites within a town according to the different class of peoples and professionals. It is stipulated in *Arthaśāstra* that the site, on being recommended by experts, should have the boundary fixed by pillars on four corners, connected by iron wires, so as to indicate the extent of the land. If the land is contiguous to another building, the

boundary should be fixed at least 3 feet (two aratni) away from the neighbours house. To avoid any nuisance to the neighbours, wells, dung, hills and water course (drains) are to be suitably emplaced between the houses, similarly places for carts, pet animals, fire place, grinding mills, water reservoir tanks etc. should be located well away from the neighboring house, or at mutually agreed suitable locations in between the houses. All these measures are to strictly adhered to for defaulting of which penalties have been stipulated (K.A. 3.8,8 to 3.8.26, Pt. 1)

While so much have been stipulated for the dwelling places obviously for the common people, the design details and architectural aspects of buildings architectural aspects of buildings are described extensively in connection with the royal residence (Book 1, chapter 20) and as related to the construction of forts (Book, 2 chapter 3)

Soil Mechanics and foundation

As are the conventions and practices with building construction, the preparation of foundation has been taken up at the out set (2.5.2) (kangle, 1960:) Though this sutra deals with the construction of underground chamber, specification as to how the floor and sides are to be constructed has also been laid down. The process of paving the are excavated walls and floor with stones is obviously meant for insulating the underground soil moisture.

But it may be logically inferred that the process is similar to the construction of structural foundation on the modern day civil engineering. Such an attribute to the concept is not altogether out of context, when it is seen that sūtras elsewhere deal with minor details about construction within or on natural soils.

This subject has developed into a very sophisticated branch of civil engineering known as soil mechanics. The discussions at length on this aspects have been prompted by the processes described in sutra 2.5.2 (K.A) and their startling similarity with the present day practices in civil engineering. These are excavation of soilmas (ii) dewatering and making then moisture

free (iii) use of strong and durable stone slabs (concrete or bricks in present practice) over the bottom of excavation.

Practical application of this principle has been obtained from archaeological excavations of Kumrahār (Pātaliputra). A pillered hall of the Mauryan period revealed the nature of foundation.

According to archaeologist is perhaps the earliest building in south Asia, employing monolithic stone pillars.

The properties and behaviour of superficial soil deposits as related to the foundation of buildings, pillars etc. another aspect attracts attention. This is concerning the stability of natural soil in an excavation as in case of the moats. Sutra 4, Chapter 3 of book (K.A) describes the construction of ditches around forts a protective measure.

It states that

... three moats to be dug round it, at a distance of one daṇḍa from each other fourteen twelve and ten daṇḍas broad, three quarters or half of the breadth deep one third at the bottom or square with the bottom, paved with stones or it the sides (only) built of stones or bricks, reaching down to (natural springs of) water or filled with water coming from elsewhere, with (arrangements for) draining excess water.

The standard slopes for flooded cuts such as canals range between 2.1 and 3.1. steeper than standard slopes should be established only on rock, on some residual soils, on dense sandy soil interspersed with boulder and on true loess. (*Terzaghi and Peck*, 1967: 415)

Royal Residence:

The Royal Buildings shall be expected facing north or east on a good building site, in the middle of the residential areas of the four virus (K.A. 2.4.6 and 2.4.7) and as per the recommendation of experts in the science of building (K.A. 2.3.3). The points to be taken into account in selection of appropriate site for settlement are that it should have advantages of natural or artificial protective measures and should be near sources of water. The royal residence should be constructed in a manner similar to the

construction of store house (K.A. 2.5. 2-3). The place may be located above it with concealed passages for entry and exit provided with mechanism, which allowed instantaneous entry into the subterranean chamber.

The floor of the prāsāda is so constructed that with the release of a mechanism it can fall down into the cellar below. (1.20.2)

(kangle, 1960) (Kangle, 1960: 49)

Architectural layouts and designs of royal palaces of much later centuries proved the viability and practicability of modern concepts. At the backyard should be rooms to be used by ladies during confinement as a sick room and also for trees and water. The latter prescription does not really fit well if taken literally. It may be assumed that the sick room is to have provisions for enough water required for treatment, ablutions and provisions for enough water required for treatment. There should be appropriate plantations as decorative and soothing greenery which provides recuperative beauteous atmosphere for the sick. The rooms for prince and princesses are to be located in the outer periphery of the residence. There should be dressing room, council chamber, assembly hall and a separate chamber for the princes governor, all to be located with reference to the central hall Dwelling places for servants and other helping hands in the royal residential service have been prescribed.

The layouts of the royal places with rooms, chambers, halls etc. as necessary in the private life of the king for discharging royal responsibilities like councils with ministers holding meetings etc. display a very high order of architectural concept. Details of space provision for stores, sick room, education and training of princes by residential governors, soldiers and guards to keep vigilance etc. have been enunciated. Intricate constructions of structures like underground chamber labyrinths concealed within walls, other camouflaging mechanisms for hiding and speedy exit have been specified with details. Architectural layout and designs of royal places of much later centuries proved the viability and practicability of these concepts.

Construction and construction Materials

Besides the important aspect in connection with the foundation preparation the sutras prescribe also the construction materials. Timber bricks and stones as construction materials have been mentioned. Presence of timber and bricks have been found in profusion within the excavations carried out of sites proved to be of Mauryan Period. Stones are not present in comparable proportion. This fact has been taken by some authority do relegate the date of *Arthaśāstra* much later than fourth century BC., on the ground that the use of stones in building construction entered into Indian practice much later.

Absence of stones near about as reliable strong material known from the dawn of the human evolution history forced the people to explore these properties in naturally available other types of materials which could suitably be used in buildings.

There is a very interesting indication about another type of construction material and process in sutra 4, book 1, Chapter 20, as a measure of protection against fire. In the same sūtra it is said that when clay is mixed with ashes produced by lightening (vaidyutena bhasmana) and water derived from hails (varaka-vara) and applied to the walls, it becomes fire proof. when almost similar process described in Matsya purāṇa (about 4th cent. A.D.) is scanned it becomes clear that the statement contains some sense and meaning to be reckoned with. It states Samudra saindhavayava vidgudagdha ca mṛttikā tayanulitam yadesom nagina dahyate nṛa. It may be seen that vaidyutena bhasmana has been expressed as vidyudaghda ca mṛttikā meaning 'earth burnt by lightening'. (*Bhattacharyaya* 1986: 84 and 127)

The architectural concept in consonance to the physical characteristic of the ground used for placement of building and spatial distribution of residences to be occupied by people of various professions is well articulated in the chapter dealing with the layout of the fortified city (Book 2 Chapter 4) (kangle, 1960:)

Moreover, each group of people should have fixed boundaries of their household according to the necessity for respective activities. Within the boundaries flower and fruit gardens are to

be cultivated and should have space for strong provisions. A cluster of ten families should have an enclosed space for well for water supply. Sanitary measures, space between houses, provisions for lighting each household protection of exposed part of the house from rains etc. have been incorporated in the process of house construction (Book 3, Chapter 9). (kangle, 1960:)

Architectural specifications of different types of buildings, be these meant for fortification, watch towers, spaces to resist outside attacks, or attacking enemies, service roads for movement of watchmen and soldiers, royal rooms within forts, ramparts, parapets, exit door, escape passages etc. or buildings ware treasure house and others reveal that the perception of living standards amenities and other functional components of the buildings had been of highest order comparable to the present day concepts and practices.

In case of community dwelling places (Book 3 Chapter 8), The sūtras demonstrate the element of effective neighbourhood planning another modern concept in town planning and building architecture. (kangle, 1960:)

The building laws propounded in *Arthaśāstra* bear a very glaring similarity with the modern municipality rules. It has been observed that-

> The laws of the *Arthaśāstra* on housing questions are surprisingly progressive and enlightened for Kauṭilya's age. They correspond to the modern municipal building laws and are vaguely in the nature of house planning. But it must be remembered that whereas the modern house planning is supposed to aim at the comfort and convenience of the members of the community, the primary object of the Kauṭilyan code is to effect a reduction in or removal of the causes that contribute to discord and friction amongst neighbours. *(Sharma*, 1950: 3-10)

To wrap up discussion and architecture, town planning and civil Engineering constructions contained in the *Arthaśāstra* and

comparing these with the western practices, the Indianness and vernacular architecture are still discernible.

The seed of development was immanent in the then existing social and political situations. A new order was to be established in a situation, which by all logic and reality can be considered as comprised of not only political but social anarchy and chaos. The approach to establishing the authority called for introducing discipline in different spheres of society, consolidating means of production and power, defining the natural resources and their appropriate utilization, collection of revenue and the like-in short ushering in of orders in every sphere which would ensure the stability of monarchical system.

Conclusion

Monarchial security, bureaucratic patterns introduced in the system and political strict adherence to orderliness must have shaped the mindset to precision attitudes to everything including space, in the layout of towns roads forts, residences, even in the arrangements of rooms within a house, etc. Besides the economy of space, the geometrical concept of space manifested the sense of aesthetic beauty in its appropriate allocation use. Thus in the concept of orderliness imparting material attribute to space in confining it by geometrical shapes, to space trimming and beautifying by pleasing layout and optimum utilization, we find not only the signs of breakthrough in the concept, but transcendental philosophy which molded the architectural technology on a higher plane, comparable to what it assumed later on till our time.

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    nātmpriyaṃ. hitaṃ rajñah prajānāṃ tu priyaṃ hitam
    Kangle, R.P. (edn) 1992, Reprint. *The Kauṭilīya Arthaśāstra*,
    MLB, Delhi. 1.19.34.
2. (i) Bhūtapūrvambhūtapūrvaṃ   vā   jandapadaṃ
    paradeśāpavāhanena svadeshābhiṣyandavamanena vā niveśayet.
    2.1 V-II, K.A. op.cit.

(ii) Śudrakarṣakaprāyam   kulaśatāvaraṃ   pañkulaśataparaṃ grāmaṃ   krosadvikrośasìmanamanyonyārakṣam niveśayet.

Astaśatagrāmyā   madhye   sthānīyam, catuḥśatagrāmyā droṇamukhaṃ,   dviśatagrāmyāhāh   karbatikam, dasagramīsaṃgraheṇa saṃgrahanaṃ   sthāpayet.

Meanings: (i) He should cause settlement of the country, which had been settled before or which had not been settled before, by bringing the people from foreign lands or by shifting the overflow (of population) from his own country.

(ii) He should cause villages to be settled consisting mostly of śudra agriculturists, with a minimum of one hundred families with boundaries intending over one krośa or two krośas (and) affording mutual protection.

(iii) He should establish a sthānīya in the middle of eight hundred villages a droṇamuhkha in the middle of four hundred villages, a karvatika in the middle of two hundred villages (and) a samgrahaṇa in a group of ten villages.

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