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# Assessing urban grain fineness and density potential – A case study for Korean urban regeneration

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***Abstract***

*For the past decade, South Korea has been attempting to break away from large-scale redevelopment practice and engaged in new urban regeneration projects targeting its declining urban areas. Those ageing districts are characterized by a general fineness of the urban grain, with small alleys and plots associated with relatively high built density. The factors used to evaluate decline are essentially socio-economic indicators coupled with a rough evaluation of the building stock decay through its age. Limitations due to the nature of the urban form – and especially its excessive fineness- are often cited as the main hindrance to regeneration, as car accessibility is poor and development scale limited. Yet, no systematic indicators or definitions of this fineness have been developed. Moreover, the limitations of these urban fabrics are relative to the expectation set by the urban code, notably in terms of density and built typology. Regeneration of fine-grained urban districts requires a reformulation of the generic urban code adapted to those specific tissues. This research attempts to clarify the notion of fineness of urban fabric in the Korean context. It identifies indicators of fineness levels using tools developed in urban morphology, notably the Spacematrix and the notions of network density. It applies those indicators to a Korean case study area and compares them to a database of urban fabric worldwide in an attempt to 'benchmark' the Korean old city and establish a relation between urban tissue fineness and acceptable or potential density. The research sits in the general framework of establishing connections between urban morphology study and urban practice such as urban regeneration projects.*

***Keyword:*** *Urban regeneration, Fine-grained urban fabric, Density, South Korea*

## Introduction

The Republic of Korea (hereafter Korea) has experienced intense urban growth since the 60s. The forms of urban development have evolved considerably, passing from low-rise organic settlements to low-rise gridded land readjustment projects to ever larger and higher collective housing complexes. The low-rise city developed until the 80s is now seen as obsolete, and shows signs of decline all around the country. Areas that are attractive to investors are redeveloped into large housing complexes while less attractive locations fall into decay (Kim, 2010). Laws were introduced in 2009 and 2013 to remediate urban decline through the notion of Urban Regeneration, and Area-Based Regeneration Initiatives are conducted countrywide. Yet, the success of such policies remains limited (Kim, 2013, Joo and Seo, 2017, Seo and Joo, 2019). Korean urban regeneration practice follows the principle of a holistic approach with three main axes: social, economic, physical and environmental. This approach does not necessarily include specific expertise and does not address critical issues such as the potential of existing urban forms. Indeed, the same simple and generic zoning rules are applied to all urban areas in Korea. As a high building density is associated with high urban development profitability, FAR limitations are maintained high. The only high-density building types fitting in

the old district can be seen as inappropriate and further devaluating the urban space. The main urban form property resulting in the decay of old districts is therefore the excessive smallness of their urban fabric (Kim, 2010, Lee and Hwang, 2013). Narrow roads and limited parking space do not meet the demand of a society that highly values automobile, and small plots are not compatible with the development practices of the big construction conglomerates that dominate the Korean building industry. In contrast, cities with small-grained urban fabrics are associated by many western scholars with attractiveness, walkability, mixed-uses and high degrees of liveability. Yet, the authors could not identify precise definitions of the concept of fine-grained urban fabric and only found a few research dedicated to the topic.

This research aims to identify criteria for the definition of different degrees, forms and patterns of urban grain fineness. The criteria will be applied in the analysis, evaluation and comparison of exemplary very fine-grained urban areas in Korea with available urban fabric samples from Europe, Asia and North America.

## Background

### Definitions and threshold of urban fineness

The first definition of urban grain identified by the authors is in the 1958 article 'A theory of urban form' (Lynch and Rodwin, 1958). The article proposes to qualify this grain as 'fine' or 'coarse'. Kropf clarifies the notion of urban grain as *"The compositional hierarchy of 'levels of scale' […], referring to the combined pattern of streets, plots and buildings*" (Kropf, 2014: 42). Caliskan and Mashhoodi associate the notion of fine-grain with that of coherence. Their study proposes that coherence is a desirable trait of the urban fabric, and introduces a simplified definition of fine-grained fabric as *"The quality of texture, consisting of a large number of small particles that marginally differ in size."* (Caliskan and Mashhoodi, 2017: 125). Numerous works establish the positive value of fine-grained fabric, associated with pedestrian-friendly, diverse and lively cities (Lynch, 1981, Siksna, 1997, Heng and Malone-Lee, 2010). Moreover, many authors advocate for an urban form that can be qualified as fine-grained, even if the term is not used (Jacobs, 1961, Lucan, 1996, Krier et al., 2009, Gehl, 2010, Sim and Gehl, 2019). The Spacematrix method (Berghauser Pont and Haupt, 2009) provides quantification tools for the fineness of urban fabric. Grain size is associated to block width or mesh and with the network density ratio N. The two measures are related, but the notion of mesh seems to ignore irregular networks and dead-end streets. In this study, the notion of network density N is used as a base measure of urban fineness.

In Korea, fine-grained urban areas are mainly associated with problems related to congested residential areas and undersized building plots (Seo and Seong, 2011). As very fine-grained fabric is a widespread issue, laws and institutional indicators offer us a good vision of what is considered too small on the level of streets, plots, and building fabrics. Urban areas showing over 50% of street length under 4 m width and over 50% plots under 90m$^2$ are priority targets for urban redevelopment. A concentration of housing units under 60m$^2$ also

constitutes a criterion of decay evaluation, as do street width of fewer than 8 meters and unit density over 70 u/ha (Daegu Metropolitan City, 2018 and Building code Art. 2 and 44).

## Study area


***Figure 1.*** *Study area location in Daegu, Korea*

***Figure 2.*** *South view over Daegu from Yeonam Park*

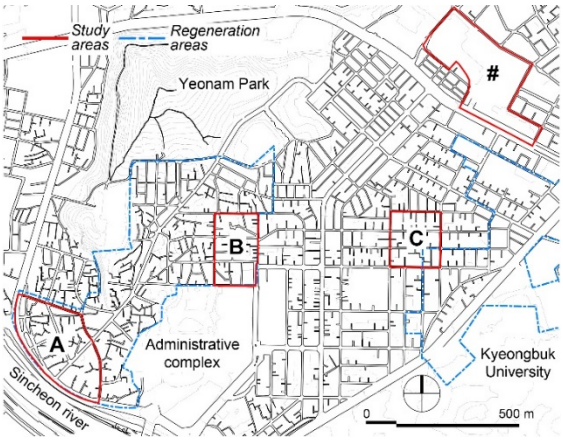


***Figure 3.*** *Map of the study area and study samples*

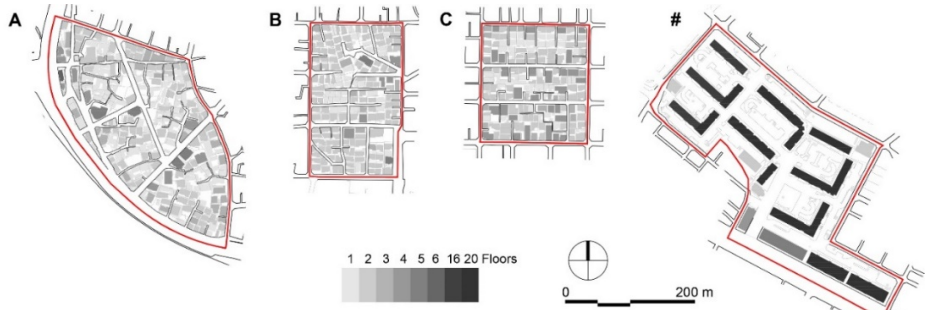


***Figure 4.*** *Detailed plan and view of the four samples areas indicated in figure 3*

This research focuses on the Sankyeok-dong district, a characteristic fine-grained residential area north of Daegu city centre (Figure 1). The district presents a consistent low-rise fabric with few buildings over 5 levels (Figure 2). The area contains a diversity of urban fabric patterns of which four were used as sample studies within this research (Figure 3): the former Joseon era rural settlement of Yeonam-gol (A), the rectified post-war informal settlement north of the administrative complex (B), the 70s land readjustment area beside Kyeongbuk University (C), and the Daewoo Apartments (#), a typical housing complex used as a reference sample in contrast to the first three (Figure 4). Korean regeneration initiatives are decided based on a threefold decline indicator: loss of population, decrease in business, and 'deteriorated' residential environment with more than 50% of buildings over 20 years old (Urban Regeneration Act Enforcement Decree Art. 17). All three samples, A, B and C, match the population and deterioration criteria while only sample B matches the business criteria (City Hall communication, Dec. 2019). One urban regeneration plan has already been conducted in the Yeonam-gol area with mitigated results, and a second one is starting along the Kyeongbuk University campus.

## Methodology

This research is based on a literature review around the notion of fine-grained urban fabric, urban form density, and urban regeneration in the Korean context. The research area is documented through maps and

building data originating from various government web portals (National Geographic Information Institute, National Spatial Data Infrastructure Portal, Daegu Metropolitan City). No comprehensive plans of both building and plot fabrics are provided in Korea. The available data showed missing updates and inconsistencies, implying a margin of imprecision.

The analysis of the selected Sankyeok-dong samples was executed with the Spacematrix method. All definitions and calculation follow the Spacematrix standards with the exception that underground levels and attics are not included in the calculation of Floor Area in order to simplify the measures (in any case, those are rare in the study area). The notion of network density N ($m/m^2$ = network length in meters divided by study area in square meters) was used as a base measure of urban fineness. The higher the density number, the smaller and finer is the urban grain size. The produced N(b) graph and fabric and island level Spacemat graphs were compared with the database of Berghauser Pont and Haupt as well as those of a 2003 ISUF international study (Kim and ISUF, 2003) and a density study report from the Canton of Geneva (Surchat-Vial and Toumi, 2012). Each database carries small differences in definition and vocabulary that must be accounted for. Particularly, the ISUF study uses 500X500m samples instead of study areas delimited by streets and plot lines following the Spacematrix approach.

## Results and Discussions

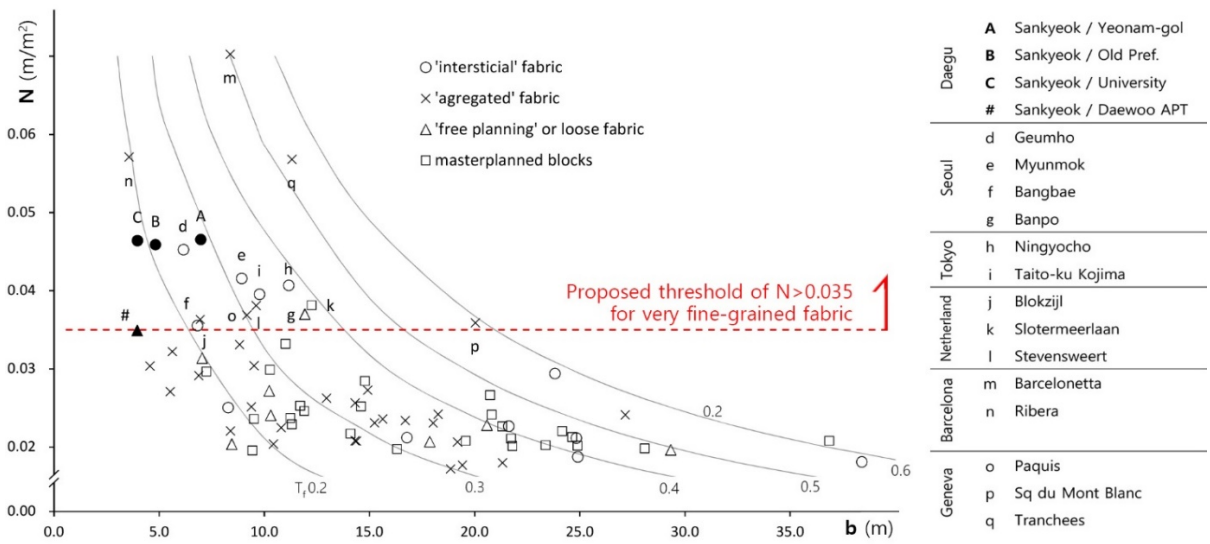


***Figure 5.*** *Nf(b) graph identifying the threshold for very fine-grained urban fabrics and specification of values of this study's samples (A, B, C, #) and 14 selected international studies' samples (d-q).*

### Network density analysis

The study of network density N constitutes a good entry point to the analysis of urban fineness. A dense network directly reflects the fragmentation of street blocks and is correlated to the need to connect many building plots. Based on data available in the 3 available databases, it is estimated that a network density N above 0.02 $m/m^2$ is already representative for a certain fineness. All available samples showing an N of 0.02 or above are initially included in the study. Samples are sorted into four broad patterns, allowing for a brief

description without images. Korean fabrics mainly belong to the 'interstitial' category, as the law prescribes a minimum setback of 50 centimetres from every limit in the absence of other specific guidelines (Building Act Enforcement Decree Art. 80.2). The N(b)graph (Figure 5) shows that the bulk of the available samples' N values remains under 0.035 m/m$^2$, constituting a threshold to identify a very fine-grained category to which this study's samples (A, B, C, #) and 14 other selected international samples (d-q) belong. All identified samples, except one, show an average street width (b) under 12 meters. No urban fabric sample from Paris, London, New York, or Los Angeles reached the proposed N value thresholds of 0.035 m/m$^2$. Only three of the 41 Dutch urban fabric samples were above the threshold while eight of the nine Korean samples did.

Only three samples display higher N values than the Sankeok-dong ones: the peculiar finely stripped urban fabric of Barcelonetta (m), with an outstanding N value of 0.07m/m$^2$, followed by the medieval urban fabric of Ribera (n) and the stripped Tranchees district of Geneva (q), both with an N value of 0.057.

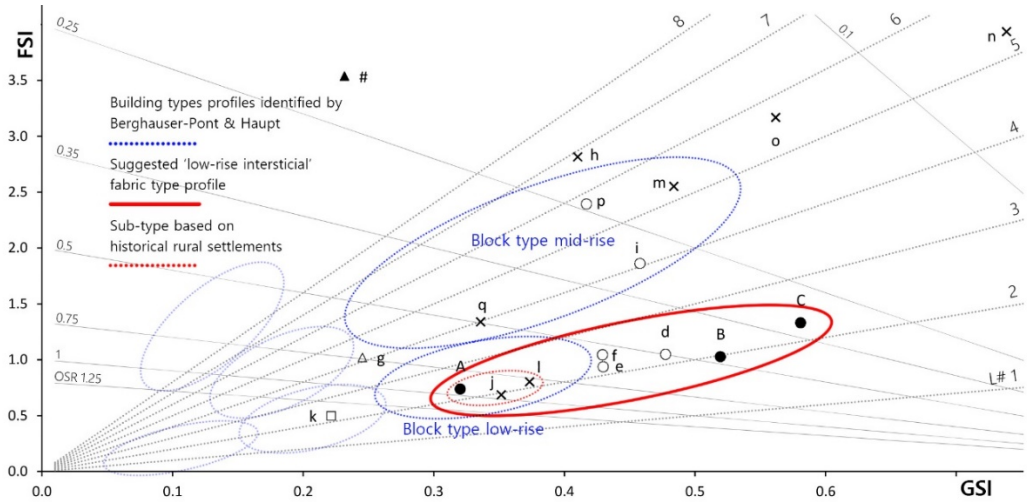


***Figure 6**. Spacemate graph on fabric scale plotting the identified very fine fabric samples*

The analysis of the fabric level Spacemate graph including all very fine-grained sample (Figure 6.) reveals a new 'low-rise interstitial fine-grained fabric' type for the Korean samples. This type features a Ground Space Index (GSI, similar to gross Building Coverage Ratio BCR) of 0.3 to 0.6 and a Floor Space Index (FSI, similar to gross Floor Area Ratio FAR) of 0.5 to 1.5. The average levels L are all between 2 and 3. The less-dense part of this new type can be considered as a sub-type represented by the Yeonam-gol old rural settlements (A), displaying similar density features to two old Dutch rural settlements (l and j). The Korean low-rise interstitial fine-grained fabric type partly overlaps with Berghauser-Pont and Haupt's low-rise block type but displays a very different configuration. The Daewoo APT (#) stands out from any other reference, with low GSI and high FSI. Barcelona's Ribera neighbourhood (n) is the most densely covered and built sample, while Barcelonetta (m), which displayed the highest N value, is located in the middle of the graph. The two Japanese samples (h and i) that seemed similar in plan and N value to the Korean samples turn out to be far denser.

A Spacemate graph on the island level, or net density excluding public space, yields similar results for the Korean samples, that have a limited ratio of public space (Figure 7). Other samples scatter differently, with

specific cases such as Geneva's 19th-century composition Square du Mont Blanc (p) rising at the very top right part of the graph, as every open space in the sample is public. The graph at the island level targets building plots only and therefore allows to represent the legal density limitations of the Korean urban code. Samples A, B, and C sit in the general residential zone 2, limiting the FAR to 220% and the BCR to 60% (Daegu Metropolitan City, 2018). Moreover, the densest building types susceptible to fit in the fine-grained fabric are the multi-family housing (Korean 'dakaku', single owner building) and the multi-household building (Korean 'dasaedae', small condominium). Dakakus are limited to 3 levels above a parking ground floor and dasedae to 4 level and parking (Building Act Enforcement Decree attachment 1). These restrictions define a specific area on the Spacemate diagram, indicated by a pink zone. The lighter pink area above four levels average can only be reached by building dasaedae, which are more costly and restrictive to build than dakaku thus less probable to happen. The redeveloped Daewoo APT sample is located in general residential zone 3, with a maximum F.A.R. with incentives of 280% and a maximum B.C.R. of 50%.

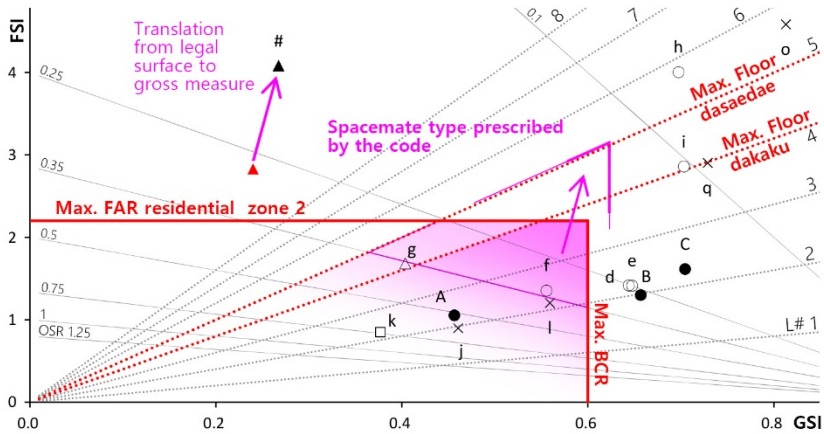


***Figure 7.*** *Spacemate graph on island scale plotting the identified very fine fabric samples and Korean code restrictions*

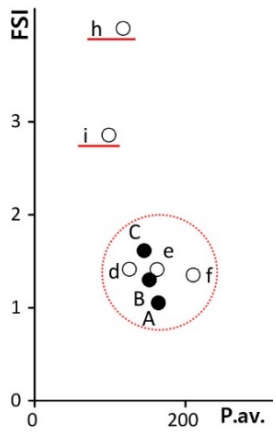


***Figure 8.*** *FSI(Pav.) graph on the fabric scale*

The FSI and GSI cannot be directly compared with the legal FAR and BCR, which exclude many volumes included in the gross calculation of those indexes. In a densely populated country like Korea, FAR is a crucial issue, and every effort is put to cram as much usable surface as possible in the legal restriction, as demonstrated in 'The FAR Game' (Kim, 2016). In the case of Sankyeok Daewoo APT, measured GSI and FSI show an increase of 12% and 40% from the declared legal BCR and FAR values. The approximate GSI and FSI position of general residential zone 2 on the Spacemate graph (indicated by a pink polygon) can be located by following a similar translation. The polygon stands high above the values measured for the three study samples A, B, C, indicating potential densification exceeding 100%. We can wonder if such real estate yield is possible and desirable in a very fine-grain fabric. The graph also shows that the GSI of many Korean samples, including two in Sankyeok-dong, overpassed the legal B.C.R. This can be related to the many illegals and provisional buildings that clutter the urban fabric.

### Further indicators of grain fineness

The Spacematrix analysis allowed for an investigation of grain fineness at the street network level. Yet, as discussed in the definitions above, urban grain is characterized on the three levels of street, plot, and building fabric. While the three might be correlated, they can also differ strongly, as demonstrated in the case of Sankyeok Daewoo Apartments, where numerous private access roads yielded a high N ratio on a single plot. In a tight plot mesh configuration, the building and plot fragmentation will tend to be strongly correlated. An indicator such as the average plot size Pav. (block area in $m^2$ divided by number of plots) can thus be a relevant complement to the network density. The real estate yield of very fine-grained fabric can be evaluated by a graph associating FSI to Pav. Figure 8 shows that very fine-grained samples form a distinct cluster, with Pav. ranging from 150 to 220$m^2$ and FSI from 1 to 1.7. Only two exceptionally fine and dense fabrics samples rise above the bulk: Ningyocho and Taiko-ku Kojima in Tokyo (h and i). If Korean fine-grained fabrics were to fill up the legal FAR ceiling, they should reach similar features as the Japanese samples.

Finally, we must note that plot and built fabric fineness are not necessarily correlated. Fabric samples such as Paris Faubourg Saint Antoine did not match our criteria of fineness while the neighbourhood appears finely fragmented. The courtyard system characteristic of this area gives access to multiple buildings via co-properties inside deep blocks, creating a fragmentation that does not appear on network or plot intensity indicators. A complete analysis of urban fabric fineness should incorporate data on co-property, unit density as well as building fragmentation as proposed by Mottelson and Venerandi (Mottelson and Venerandi, 2020).

## Conclusions

This research proposed criteria of urban grain fineness using the Network Density and Plot Average indicators. Identified thresholds of fineness showed that the Korean 'old' residential neighbourhoods in search of a way for regeneration rank amongst the finest urban fabrics in all the available database. They form a particular fabric type on the Spacemate graph, that could not be matched with any other sample. While this 'low-rise interstitial fine-grained fabric' type displays net density (FSIi) ranging from 1 to 1,6, the urban code allows for value twice that high. The Spacemate profile of the Korean urban code for the concerned general residential zone 2 corresponds to no identified fine-grain fabric. The bulk of the studied very fine-grained fabric samples showed FSI under 2. This reveals that the high-density limits of Korean zoning can be a hinder to the regeneration of very fine-grain fabrics, as building plots either underperform in the perspective of potential investor looking at the FAR yield or 'congest' reaching built densities that correspond to no desirable or established urban form. In the perspective of urban regeneration, it seems necessary to clearly establish what kind of urban form Korean fine-grained fabrics are expected to evolve toward, and what qualities it carries. The ideas on urban form issued from Western literature should be handled with care as they deal with a very different and overall less fine-grained urban fabric.

This study needs to be complemented with a wider database of fine-grained urban fabric from all over the world, as well as from Korea. Moreover, further detailed indicators of grain fineness should be elaborated.

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